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Abstract

This dissertation explores the diverse effects of external shocks and interventions on corporate behavior, financial markets, and urban environments, offering new insights into firm strategies, governance dynamics, and urban policy outcomes. Through three empirical essays, key questions are addressed at the intersection of finance, corporate governance, and urban economics, utilizing robust data-driven approaches.

Chapter 1 focuses on the role of hedge fund activism in transforming corporate governance by inducing changes in board composition and structure. It examines how activist campaigns affect board structure and subsequent firm value. We document large-scale increases in board turnover following activist interventions, driven both by entries and exits. Turnover events are not priced by the market prior to activism but become valuable following engagements. Activists target underperforming board members, indicating a 'weakest link' strategy rather than an attempt to enhance overall board skill sets. Consistent with this, activist-driven board turnover appears to not alter board diversity or aggregate board skills, and individual director characteristics explain only a minor fraction of the observed valuation effects. These results suggest that activism is valuable not because of who the board members are that are appointed or removed. We explore the origins of new director appointments and investigate the career trajectories of activist-appointed directors to understand the long-term impact of activist campaigns.

Chapter 2 examines the urban and economic consequences of infrastructure development, focusing on the impact of inaugurations of metro stations on housing prices in Tehran. The opening of a new metro station, as a mode of the transportation corridor, could potentially have different effects on housing prices. We have investigated its effect on the value of residential properties around those stations, using data from large expansions of the metro network in Tehran, Iran. In the period of our study (April 2010 to December 2018), forty-five metro stations were inaugurated in Tehran. We use a difference-in-differences regression method to identify the causal effect of interest, where adjacent properties are used as the treatment group and similar but distant properties as the control group. The results indicate that, on average, the adjacent properties are affected by a 3.7 percent increase in price relative to distant properties. We also extend our study by categorizing new metro stations according to the extent of ex-ante access to other modes of public transportation such as bus rapid transit (BRT). We find a 2 to 11 percent positive effect of new metro stations in regions with lower public transport, while in regions with an ex-ante extensive public transportation system, we find a less than 2 percent positive effect.

Chapter 3 investigates the corporate response to the 2022 Russian invasion of Ukraine by analyzing which publicly listed firms chose to withdraw, suspend, or continue their operations in Russia, how quickly they announced these decisions, and how the stock market reacted. Using data from the KSE Institute on 1,218 firms with pre-war Russian exposure, the study examines how country-level factors (trade ties, sanctions), industry characteristics (consumer visibility), and firm-level attributes (financial flexibility, reputation, and operational entanglement) influenced these decisions. Findings suggest that firms with higher public visibility and stronger ESG social scores were more likely to exit, while firms from countries with stronger trade relations with Russia were less inclined to withdraw. Timing analysis using a Cox proportional hazards model shows that firms with

greater liquidity and reputational concerns responded faster. Event studies reveal that firms with Russia exposure suffered significantly negative abnormal returns following the invasion, and market reactions varied based on the nature of firms' announcements.

Looking ahead, this dissertation opens avenues for future research on the themes explored in these essays. In Chapter One, future research could enhance our findings by incorporating more detailed data on hedge fund characteristics, such as investment strategies and prior activism success rates, as well as the comprehensive CVs of directors, including their skills, prior board experience, and network influence. Such data would allow for a deeper understanding of the mechanisms driving board turnover and the specific tactics employed by hedge funds. Expanding the scope of analysis in this way could offer a more nuanced view of how hedge fund activism shapes corporate governance and contributes to firm value. In Chapter Two, future research could extend our analysis by distinguishing between the announcement date and the opening date of metro stations, examining how housing prices evolve from the time of announcement to the actual inauguration. This approach would provide a more precise understanding of the anticipatory effects of infrastructure projects. Additionally, future studies could broaden the scope by evaluating the total value added by metro openings, considering not only housing prices but also other economic and social dimensions, such as employment growth, accessibility improvements, and commercial property values. Such extensions would offer a more comprehensive view of the economic benefits of urban transit expansions. In Chapter Three, further studies could build on this work by examining not only the determinants but also the consequences of withdrawal, particularly from the perspective of social impact on stakeholders, including employees, communities, and consumers. Another avenue for improvement lies in expanding the dataset to include more countries, providing a broader perspective and deeper insights into how firms across different regions respond to similar crises. Such extensions would enhance our understanding of the interplay between corporate strategy,

reputational considerations, and geopolitical events.

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Introduction

This thesis comprises three independent essays addressing distinct topics within the broader fields of finance, corporate governance, and urban economics. Each chapter reflects a unique inquiry into key questions relevant to its respective field, grounded in rigorous empirical analysis. While these essays are not directly related, they collectively highlight the diversity and breadth of contemporary economic challenges and contribute to distinct areas of academic and practical significance.

The first essay delves into the realm of corporate governance, exploring the transformative influence of hedge fund activism on board turnover and director characteristics. Boards of directors are central to ensuring firms act in the best interests of their shareholders, and activist investors have emerged as powerful agents of change in this domain. This study leverages a large dataset of activist campaigns to provide a detailed examination of how these interventions impact board composition. Beyond addressing underperformance, the findings suggest that the mere presence of activists imposes a disciplinary effect on incumbent directors, driving improvements in governance and shareholder value. This essay contributes to the understanding of micro-level governance dynamics, shedding light on mechanisms that extend beyond conventional narratives of skill enhancement or diversity improvements.

The second essay shifts focus to urban economics, examining the relationship between

transportation accessibility and housing markets in the context of Tehran. Public transit infrastructure, particularly metro systems, plays a pivotal role in shaping urban development and property values. Using administrative data encompassing over a million real estate transactions, this study employs causal inference techniques to isolate the effects of metro station inaugurations on housing prices. The findings not only highlight the economic benefits of improved accessibility but also reveal variations in these effects based on existing public transportation infrastructure and neighborhood characteristics. By quantifying the market's valuation of metro accessibility, this research offers insights into urban policy evaluation and infrastructure investment decisions.

The third essay addresses the critical issue of corporate decision-making during geopolitical crises, focusing on the Russia-Ukraine war. In the face of unprecedented sanctions and global scrutiny, many firms with operations in Russia faced a dilemma: whether to withdraw, suspend, or continue their activities. This study investigates the factors driving these decisions, with a particular emphasis on the role of corporate reputation as measured by ESG performance and social exposure. Employing a robust methodology that includes event studies and regression analysis, the research demonstrates that firms with higher reputational capital and social visibility were more likely to withdraw, prioritizing long-term public trust over short-term operational gains. These findings underscore the intricate balance between ethical considerations and financial imperatives in the face of global crises.

While the chapters of this thesis are diverse in topic, they share a commitment to rigorous empirical analysis and practical relevance. Methodologically, the research employs a range of advanced econometric techniques, including difference-in-differences estimation, propensity score matching, and event study analysis, to ensure robust and credible insights. These approaches allow for a deeper understanding of the causal relationships underlying the phenomena under study, moving beyond descriptive analyses to uncover

actionable implications. Rather than attempting to artificially unify these essays under a single theme, this thesis embraces their independence as a strength. Each chapter stands as a testament to the diversity of economic challenges and the versatility of empirical research in addressing them. Together, they reflect the richness of economic inquiry and its capacity to inform better governance, policy, and decision-making in an increasingly complex world.

Chapter 1

Activists Targeting Boards[1]

1.1 Introduction

Boards of directors are central to corporate governance, responsible for monitoring management, advising on strategic decisions, and ensuring that firms act in the best interests of their shareholders. Activist investors, particularly hedge funds, play a key role in this process by influencing board composition and firm outcomes. Activist investors are targeting companies at unprecedented rates: In 2023, 23 percent of Russell 3000 companies reported shareholder activism as a key risk factor in their annual reports as shown in studies by Adams and Ferreira (2009) and Adams et al. (2018)). While substantial literature explores the mechanisms, consequences, and effectiveness of activist campaigns, there is limited research on their impact on board turnover and skill composition. Our paper's contribution is to provide large-sample evidence for how hedge fund activism affects board structure, the pattern of director exits and entries, the characteristics of both incumbent and newly appointed directors, and the consequences of these changes for shareholder

[1]This chapter is based on the paper "Activists Targeting Board" coauthored with Hannes Wagner and Selen Eski.

value.

Prior work establishes that activism often leads to the replacement of directors, with a common narrative that activists improve governance by identifying and removing underperforming board members, presumably replacing them with more skilled, experienced, or otherwise qualified candidates who can better serve shareholder interests. Moreover, some scholars argue that activists might enhance board diversity or skill sets, while others suggest that activists target specific directors perceived as weak links, rather than trying to improve the overall profile of the board.

We start by examining the scale and nature of board turnover following activist engagements. Using one of the most comprehensive samples of hedge fund activist campaigns to date, from 1994 to 2024, our analysis shows that activist interventions trigger a sharp increase in both exits of incumbent directors and entries of new board members. While one might expect that the newly appointed directors bring distinctive skills or enhance overall board diversity, our results indicate that the valuation effects associated with these changes are not driven by director characteristics. Indeed, contrary to the notion that activism leads to fundamentally more skilled or diverse boards, we find that the composition of the board's attributes remains relatively stable and does not fully explain the positive valuation effects that emerge.

Building on previous insights, we analyze the career paths of activist-appointed directors. While activists appear adept at identifying replaceable directors and increasing their turnover probability, a key question is whether the "activist-appointed" cohort represents a stable pool of talent that remains in the firm's governance structure or if these new directors are more transient. Tracing the subsequent career paths of these directors, we show that the activist cohort of directors is significantly more transient and less likely to have lasting impact on the governance of targeted companies.

Our findings thus raise important questions about the underlying mechanisms by which activism adds value. While existing literature has documented that hedge fund activism improves performance and governance outcomes, our results suggest that the benefit is not necessarily about who is on the board. Instead, it may stem from broader disciplinary forces set in motion by the activist's presence. That is, activists might improve governance simply by credibly threatening board turnover, disciplining incumbent directors who might otherwise fail to serve shareholder interests. The mere possibility of replacement could inspire incumbent directors to perform better, even if the candidates who enter the boardroom do not exhibit superior qualifications on paper.

Our evidence suggests that the increase in board turnover following activism, combined with the selective targeting of underperforming directors, is indeed associated with subsequent improvements in firm value. However, these improvements do not hinge solely on director-specific attributes, nor do they necessarily lead to a more diverse or more skilled board. Instead, activists appear to enhance governance by imposing discipline on incumbent directors and ensuring that the board remains accountable to shareholders.

Our paper contributes to the growing literature on hedge fund activism by providing novel insights into how activism reshapes board structure. Prior research has focused on activism's impact on firm performance, financial outcomes, and governance practices (for example, Brav et al. (2008); Gantchev (2013), Brav et al. (2010)). We extend this literature by systematically documenting the scale, timing, and valuation consequences of board turnover triggered by activism. While earlier work notes that activists may remove underperforming directors (for example, Fedaseyeu et al. (2018) and Feng and Wang (2016)), we show that turnover increases sharply after campaigns, driven more by director entries than exits, and that these changes do not appear to improve aggregate board skill levels. Our findings also connect to the literature on co-opted directors (see Coles et al. (2014)), suggesting that activists may target directors perceived as excessively

aligned with entrenched management rather than those lacking in skill or experience.

Second, we contribute to research on board composition and director skills (for example, Adams and Ferreira (2009); Adams et al. (2018)), by linking activist campaigns to changes in board demographics, skills, experience, and educational background. Our results suggest that activists do not systematically seek more diverse boards but rather use director replacement as a disciplinary mechanism. This finding complements prior work (for example, Bebchuk et al. (2009)) by showing that activism pressures boards without necessarily enhancing director qualifications.

Our results also contribute to the literature on stock market responses to governance changes (for example, Jenter and Lewellen (2021); Kim et al. (2020) and Nguyen et al. (2022)) by showing that the market reacts positively to board turnover events during activist campaigns—regardless of who leaves or joins the board—highlighting that investor value derives more from the threat of change than from the specific characteristics of directors.

1.2 Sample and Summary Statistics

We construct, to our knowledge, the most comprehensive sample of all hedge fund activist campaigns to date, over a 31-year period, from 1994 to 2024. For this we combine data from Brav et al. (2008) and the specialist data provider Diligent [2]; campaigns for the 1994-2016 period are from Brav et al. (2008) and for the 2017-2024 period from Diligent. We add board composition and individual characteristics of all outside board members for publicly traded firms from BoardEx, including personal board committee appointments and personal characteristics, such as education, non-board employment and experiences. We add director biographies from Capital IQ. Firm financial and stock price data are

[2]We are very grateful to Alon Brav and coauthors for kindly making their data, updated to 2016, available to us.

from Capital IQ (COMPUSTAT) and CRSP, respectively.

1.2.1 Hedge Fund Campaigns

Our full sample includes 3,845 activist campaigns between 1994 and 2024. The campaigns involve 1077 unique hedge funds and 2432 unique targeted companies. Panel A of Figure (1.1) shows a steady increase in campaigns until peaking in 2008, followed by a decline and stabilization at lower levels. The 2020 decrease reflects the impact of the COVID-19 pandemic on activism activity. Panel B illustrates the number of unique hedge funds and targeted firms each year. Both peak around 2007-2008 and then show a similar pattern to number of campaigns overall.

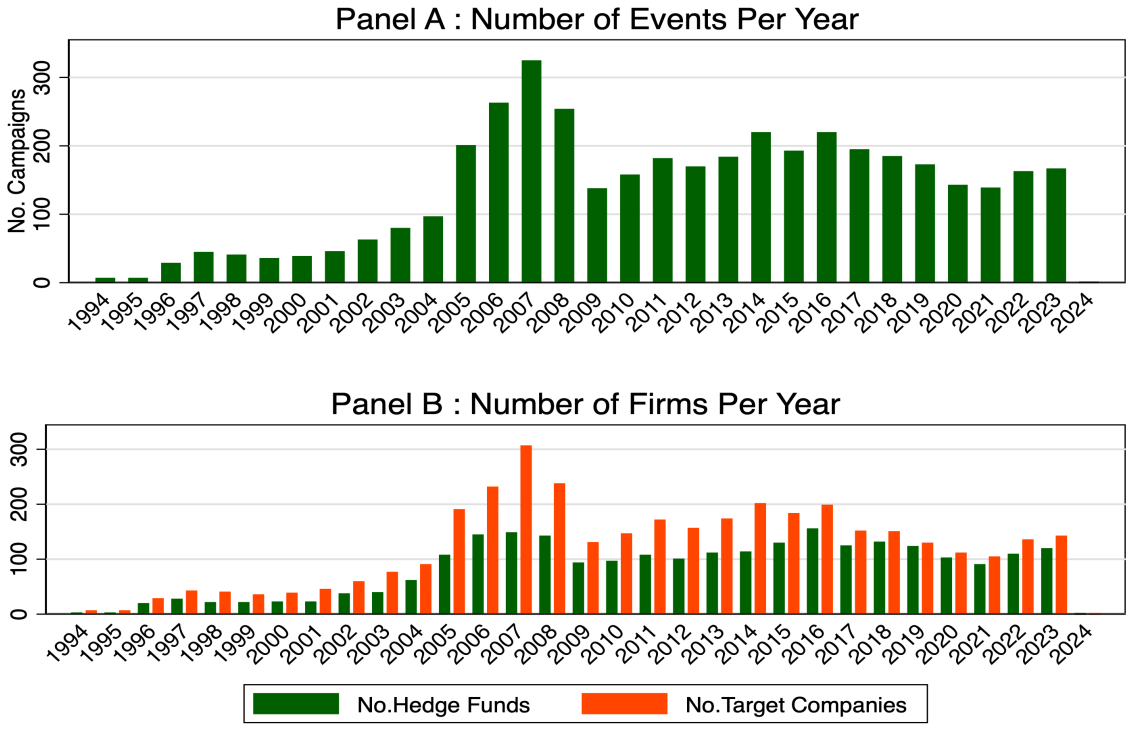

Figure 1.1: Hedge Fund Activism by Year

Note: In Panel A, bars indicate the number of hedge fund activism campaigns by year. In Panel B, No. Hedge Funds and No. Target Companies indicate the number of unique hedge funds and the number of unique targeted firms, by year.

1.2.2 Board Members

We next provide descriptive statistics for all board members of firms targeted by activists in Table (1.1). Our sample contains 23,845 outside directors, with all characteristics measured at the fiscal-year end preceding the activist. Consistent with our sampling frame, all directors are classified as outside (independent) board members. A substantial proportion of directors serve on key board committees: 47% on audit, 45% on compensation, and 44% on nominating/governance committees. Around 12% of directors hold leadership roles as board chairs or lead directors. A majority (57%) are classified as co-opted—i.e., appointed after the current CEO—and 18% have prior experience with activist campaigns.

We observe substantial variation in board-relevant expertise. For instance, 60% possess management experience, 56% have business-specific skills, and 42% have financial or accounting expertise. Other common skills include outside executive experience (63%), outside board experience (83%), and entrepreneurial backgrounds (28%). Technological, legal, academic, and marketing skills each occur in roughly 10–14% of the sample, while sustainability (1%) and risk management (2%) remain rare.

The average director is 57.6 years old, has served on the board for 4.9 years, and is well educated: 94% hold an undergraduate degree, 22% have a graduate degree, and 38% hold an MBA. Female representation remains limited at 16%.

Panel B reports firm-level characteristics as of the most recent financial statement prior to campaign initiation. The average target firm has total assets of close to US$ 4 billion, with a median market capitalizaiton of 5.62 in logarithmic terms. The sample includes firms with considerable heterogeneity in fundamentals: the mean book-to-market ratio is 0.71, average asset growth is 3%, and both ROA and cash flow average 1%. Dividend payouts are modest, with a 1% yield, and firms exhibit moderate leverage, with debt comprising 21% of assets on average. Boards are of average size, with 6.6 members.

Table 1.1: Summary Statistics

Panel A: Board Member Characteristics						
	Mean	Median	Min	Max	SD	Obs
Outside director	1.00	1.00	1.00	1.00	0.00	23,845
Audit committee	0.47	0.00	0.00	1.00	0.50	23,845
Compensation committee	0.45	0.00	0.00	1.00	0.50	23,845
Nom./Gov. committee	0.44	0.00	0.00	1.00	0.50	23,845
Board chair / Lead director	0.12	0.00	0.00	1.00	0.33	23,845
Co-opted director	0.57	1.00	0.00	1.00	0.50	23,845
Activism experience	0.18	0.00	0.00	1.00	0.39	23,845
Skills: Academic	0.12	0.00	0.00	1.00	0.32	23,845
Skills: Company business	0.56	1.00	0.00	1.00	0.50	23,845
Skills: Compensation	0.14	0.00	0.00	1.00	0.34	23,845
Skills: Entrepreneurial	0.28	0.00	0.00	1.00	0.45	23,845
Skills: Finance/accounting	0.42	0.00	0.00	1.00	0.49	23,845
Skills: Governance	0.11	0.00	0.00	1.00	0.31	23,845
Skills: Government/policy	0.09	0.00	0.00	1.00	0.29	23,845
Skills: International	0.22	0.00	0.00	1.00	0.41	23,845
Skills: Leadership	0.11	0.00	0.00	1.00	0.31	23,845
Skills: Legal	0.12	0.00	0.00	1.00	0.32	23,845
Skills: Management	0.60	1.00	0.00	1.00	0.49	23,845
Skills: Manufacturing	0.07	0.00	0.00	1.00	0.25	23,845
Skills: Marketing	0.14	0.00	0.00	1.00	0.35	23,845
Skills: Outside board	0.83	1.00	0.00	1.00	0.37	23,845
Skills: Outside executive	0.63	1.00	0.00	1.00	0.48	23,845
Skills: Risk management	0.02	0.00	0.00	1.00	0.15	23,845
Skills: Scientific/R&D	0.10	0.00	0.00	1.00	0.30	23,845
Skills: Strategic planning	0.22	0.00	0.00	1.00	0.41	23,845
Skills: Sustainability	0.01	0.00	0.00	1.00	0.09	23,845
Skills: Technology	0.12	0.00	0.00	1.00	0.33	23,845
Age	57.55	58.00	33.00	77.00	9.15	23,845
Tenure	4.93	3.39	0.02	23.13	4.83	23,845
Female	0.16	0.00	0.00	1.00	0.37	23,845
Education: Undergraduate	0.94	1.00	0.00	1.00	0.23	23,845
Education: Graduate	0.22	0.00	0.00	1.00	0.41	23,845
Education: MBA	0.38	0.00	0.00	1.00	0.48	23,845
Panel B: Target Firm Characteristics						
Total asset	3.95	0.48	0.01	86.41	11.90	3,845
Log(Market Cap)	5.88	5.62	1.87	11.21	1.92	3,845
Book-to-market	0.71	0.59	-1.14	3.90	0.69	3,845
Growth	0.03	0.01	-0.90	1.61	0.29	3,845
ROA	0.01	0.02	-0.22	0.12	0.05	3,845
Cash flow	0.01	0.02	-0.29	0.16	0.06	3,845
Div. yield	0.01	0.00	0.00	0.11	0.02	3,845
Leverage	0.21	0.15	0.00	0.97	0.23	3,845
Board Size	6.62	6.00	1.00	18.00	2.31	3,845
Outsiders share	1.00	1.00	1.00	1.00	0.00	3,845

This table reports director characteristics in Panel A and firm characteristics in Panel B, for the full sample of 3,845 activist campaigns, 1994 to 2024, as of fiscal-year end prior to the activist engagement date. All variables are described in Table A1 in the Appendix.

1.2.3 Matched Firms

To accurately assess the impact of hedge fund activism campaigns on board structure, we require a control group composed of matched firms. The matching process is essential for isolating the causal effects of these campaigns on the targeted firms. We use a propensity score matching approach, matching each targeted firm by its closest neighbor. Matched firms are selected during the pre-activist fiscal year and within the same broad industry (1-digit SIC code). For each activist campaign, we choose a non-target firm with the closest propensity score. For our 3,845 campaigns we thus obtain 3,845 matched firms. Table (1.11) in Appendix shows for the combined sample of campaigns and matched firms the determinants of being targeted by activist hedge funds, using probit estimates of targeting. Consistent with prior results for US (e.g. Brav et al. (2008)) and international (Becht et al. (2017)) activism samples, firms are more likely to be targeted if they are small, less profitable, and have boards that are relatively larger, older and with longer average tenure.

1.3 Results

In this section, we present the results of our analysis on the impact of hedge fund activism on board characteristics turnover, and related outcomes.

1.3.1 Board Turnover

Board turnover is expected to increase around activism events, driven both by the replacement of existing directors and the appointment of new ones. In both cases, the goal is to increase the presence of directors who are either aligned with the activist's objectives or possess instrumental expertise to achieve them. Activist hedge funds engage with boards primarily to influence strategic decision-making and enhance shareholder value. However,

incumbent firms often resist these efforts to varying degrees and for a range of reasons, including concerns about control, reputational risk, or disagreement with the activist's agenda.

To better understand the impact of hedge fund activism on board characteristics, we compare board turnover and board size between target and matched firms in event time. Figure (1.2) reports the statistics in event time, for 21 quarters, centered on the quarter of the campaign announcement date. Beginning with board size in the top-left panel of the figure, boards grow slowly in event time, presumably for regulatory reasons, by roughly 0.2 percent per quarter. Leading up to the campaign, target firms exhibit a significant increase in board size growth coinciding with the quarter before the campaign announcement. The control group does not exhibit any comparable change in growth rate. The difference suggests that activist campaigns contribute to board expansions by marginally appointing more directors than those leaving the board at the same time.

Considering board turnover next, the top-right panel show total turnover—entries and exits over total board size—while the bottom-left and bottom-right panels break it down into exit and entry ratios, respectively. Total turnover rises significantly for target firms around the campaign announcement, peaking 6 months afterwards, while the control firms maintain a consistent and much lower turnover rate. Within this turnover, the entry ratio shows a more pronounced increase compared to the exit ratio. This sharper rise in the entry ratio indicates that activists prioritize appointing new directors to expand the board more rapidly than replacing existing members. This is consistent with the observed increase in board size, confirming that board expansions are driven primarily by new appointments rather than exits alone.

Overall, the entry of new board members is more significant and sustained than exits, reflecting activists' strategy to not only remove incumbent directors but also increase

board size to accommodate new appointees who support their objectives. Control firms, in comparison, show minimal changes in both exit and entry ratios, underscoring the substantial impact of hedge fund activism on board composition in target firms.

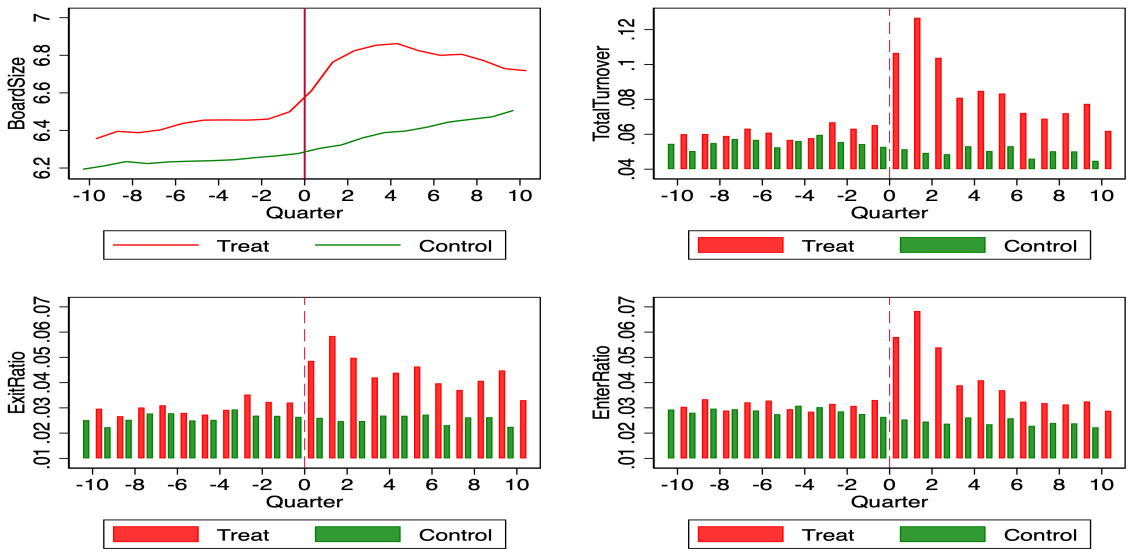

Figure 1.2: Board Turnover Around Activism Campaigns

Note: The figure shows board turnover, exits and entries, and board size statistics for the full sample of 3,845 activist campaigns, 1994 to 2024. The four panels indicate, within 10 quarters before and after announcement dates of activist campaigns, average board size and board turnover, exits and entries relative to board size.

Across all four panels, pre-announcement trends in outcomes are broadly parallel between treated and control firms, lending support to the parallel trends assumption underlying a difference-in-differences estimate, which we use to quantify the causal effects of hedge fund activism on board turnover and board characteristics. For the analysis we include the period from 10 quarters before to 10 quarters after activist campaigns. This includes 69,167 firm-quarter observations for targeted firms and 69,215 for matched control firms, yielding a total of 138,382 firm-quarter observations. The dependent variable is defined as the quarterly ratio of entries or exits within four quarters post-campaign, divided by

board size. We estimate:

$$\text{Turnover}_{it} = \alpha_{it} + \gamma \cdot (\text{Post} \times \text{Treat}) + \beta_1 \cdot (\text{firm chars})_{it} + \beta_2 \cdot (\text{Board chars})_{it} + \lambda \cdot \text{Year}_t + \mu \cdot \text{Industry}_i + \epsilon_{it} \tag{1.1}$$

where Post is a dummy variable for 4 quarters beginning in the quarter of the campaign announcement data; Target is a dummy variable for whether the firm is targeted by an activism campaign. The coefficient for Post x Target represents the differential effect of activism on turnover in target firms relative to matched firms. The results, reported in Table (1.2), indicate a positive and significant increase in both entry and exit rates following activist campaigns. Exits increase substantially following activist engagements, with estimated coefficients ranging from 1.47 to 1.60. The economic effect on entries is even larger, with coefficients between 1.67 and 2.22. Among the control variables, larger firms and higher cash flow firms experience less board turnover. Larger boards have less exits and higher entries, suggesting greater capacity to absorb new members without relying on turnover. Higher average age and higher average tenure are associated with lower exit and entry rates.

Table (1.3), Panels A and B examine the sensitivity of exits and entries, respectively, in the first four quarters following activist campaigns. In Panel B, the Target x Post event coefficient is highest in the first and second quarter (1.85 and 1.87), reflecting an initial spike in exits, with the effect diminishes slightly during the subsequent quarters. Panel C shows a similar pattern for entries, with the highest sensitivity in the first quarter (2.87), followed by a gradual decline. Overall, the results confirm that hedge fund activism is associated with significant board turnover, with a more pronounced effect on entries than exits, particularly within 6 months of the beginning of a campaign.

To further validate the results for board turnover, we illustrate the parallel trend of turnover effects before and after activist campaigns. Figure (1.3) in the Appendix demon-

Table 1.2: Turnover of Board Members - Difference in Difference Estimates

	Exits			**Entries**		
	(1)	(2)	(3)	(4)	(5)	(6)
Target x Post	1.510***	1.452***	1.583***	2.217***	2.206***	1.674***
	(0.166)	(0.166)	(0.157)	(0.138)	(0.138)	(0.130)
Post	-0.071	-0.092	-0.002	-0.133*	-0.137**	-0.042
	(0.079)	(0.079)	(0.079)	(0.068)	(0.069)	(0.069)
Log(Market Cap)		-0.688***	-0.207**		-0.090	-0.140**
		(0.090)	(0.091)		(0.066)	(0.071)
Book-to-Market		-0.002	0.002		0.004	0.003
		(0.011)	(0.009)		(0.003)	(0.004)
Growth		-0.002	-0.002		0.000	0.001
		(0.002)	(0.002)		(0.001)	(0.001)
ROA		-0.663	-1.644		-2.334	-1.317
		(1.648)	(1.555)		(1.538)	(1.498)
Cash flow		-2.509***	-2.572***		-1.275**	-1.252**
		(0.824)	(0.751)		(0.629)	(0.601)
Div. yield		4.286	4.212		-0.454	-0.520
		(3.905)	(3.686)		(0.855)	(0.888)
Board Size			-2.168***			0.931***
			(0.085)			(0.053)
Avg. age			-0.105***			-0.114***
			(0.028)			(0.023)
Avg. tenure			-0.732***			-0.836***
			(0.046)			(0.038)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	138,382	138,382	138,382	138,382	138,382	138,382
R-squared	0.070	0.073	0.120	0.070	0.070	0.115

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

This table reports turnover rate of boards of directors in target companies. The sample includes all targeted and matched firms and considers only non-executive board members for [-10,+10] quarters, centered on the quarter of the activist campaign. There are 138,382 firm-quarter observations, of which 69,167 are targeted firm-quarter observations and 69,215 are matched firm-quarter observations. The 138,382 firm-quarter observations include 61,665 unique board members. The dependent variables are the quarterly exit (columns 1-3) and entry (columns 4-6) ratios, scaled by board size. In Panel A, Post is equal to one for 4 quarters following the activist engagement announcement quarter; Target is equal to one for targeted firms and 0 for matched firms. All variables are described in Table A1 in the Appendix. Standard errors are clustered at the firm level and reported in parentheses. *, ** and *** indicate statistical significance at the 10%, 5% levels and 1 %.

Table 1.3: Sensitivity of Turnover Timing

Panel A: Sensitivity of Exits Following Activist Campaigns				
	(1)	(2)	(3)	(4)
	Post=Q1	Post=Q2	Post=Q3	Post=Q4
Target x Post	1.853***	1.872***	1.672***	1.583***
	(0.245)	(0.192)	(0.166)	(0.157)
Post	-0.022	-0.071	-0.072	-0.002
	(0.107)	(0.088)	(0.080)	(0.079)
Control Variables	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Observations	138,382	138,382	138,382	138,382
R-squared	0.120	0.120	0.120	0.120

Panel B: Sensitivity of Entries Following Activist Campaigns				
	(1)	(2)	(3)	(4)
	Post=Q1	Post=Q2	Post=Q3	Post=Q4
Target x Post	2.873***	2.550***	2.012***	1.674***
	(0.206)	(0.168)	(0.144)	(0.130)
Post	-0.100	-0.102	-0.107	-0.042
	(0.096)	(0.079)	(0.071)	(0.069)
Control Variables	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Observations	138,382	138,382	138,382	138,382
R-squared	0.117	0.117	0.116	0.115

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

In Panels A and B, the Post event dummy is equal to first, second, third or fourth quarter after the activist engagement announcement quarter, for exits and entries, respectively. All variables are described in Table A1 in the Appendix. Standard errors are clustered at the firm level and reported in parentheses. *, ** and *** indicate statistical significance at the 10%, 5% levels and 1 %.

strates that turnover rates in target and control firms follow similar trends prior to the campaign. Following the campaign (quarters 0 to +10), there is a clear divergence, with turnover rates significantly increasing in targeted firms.

1.3.2 Board Characteristics

The next set of results examines whether and how hedge fund activism affects board characteristics in targeted firms. In Table 3, the dependent variables are board characteristics—age, tenure, female board members, education outcomes—Bachelor's, Master's, and MBA—, all scaled by board size and measured at quarterly frequency. The model specification is:

$$\text{Outcome}_{it} = \alpha_{it} + \gamma \cdot (\text{Post} \times \text{Treat}) + \beta \cdot (\text{firm chars})_{it} + \lambda \cdot \text{Year}_t + \mu \cdot \text{Industry}_i + \epsilon_{it} \quad (1.2)$$

where, as before, Target indicates targeted firms, and Post indicates the four quarters following the campaign. The interaction term Treat x Post captures the differential effect of activism on board characteristics. As the Table (1.4) shows, the interaction coefficients for age and tenure are significantly negative at -0.497 and -0.345, respectively, indicating that activism is associated with reduced average age and tenure of boards, which is partially a mechanic effect of increased turnover. Additionally, the share of co-opted directors significantly increases following activism, with a coefficient of 0.014, suggesting that new directors are more likely to have been appointed under the current CEO. However, there are no significant changes in female share, or education levels, indicating a lack of change in board composition. [3]

[3] A future version of this paper will include an analysis of board skill composition and activism-induced changes of those skills, relying on the LLM-assessed individual director skills reported in Table (1.1), Panel A.

Table 1.4: Changes in Board Characteristics

	Age	Tenure	Female	Edu UD	Edu MD	Edu MBA	Co-opted
Target x Post	-0.497***	-0.345***	0.002	0.041	0.008	-0.028	0.014***
	(0.061)	(0.032)	(0.002)	(0.155)	(0.170)	(0.208)	(0.005)
Post	0.093***	0.103***	-0.000	-0.007	-0.056	0.110	-0.006**
	(0.035)	(0.018)	(0.001)	(0.093)	(0.102)	(0.116)	(0.003)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	138,382	138,382	138,382	138,382	138,382	138,382	138,382
R-squared	0.775	0.778	0.786	0.838	0.786	0.790	0.593

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.001$

This table reports the changes in board characteristics following activist campaigns. The sample includes all targeted and matched firms and considers only non-executive board members for [-10,+10] quarters, centered on the quarter of the activist campaign. There are 138,382 firm-quarter observations, of which 69,167 are targeted firm-quarter observations and 69,215 are matched firm-quarter observations. The 138,382 firm-quarter observations include 61,665 unique board members. The dependent variables are the quarterly board average for age, tenure, female directors, co-opted directors, directors with undergraduate, master and MBA degrees scaled by board size. Post is equal to one for 4 quarters following the activist engagement announcement quarter; Target is equal to one for targeted firms and 0 for matched firms. The dependent variables are board-average age, tenure, female share, undergraduate degree share, master's degree share, MBA degree share and co-opted share. All variables are described in Table A1 in the Appendix. Standard errors are clustered at the firm level and reported in parentheses. *, ** and *** indicate statistical significance at the 10%, 5% levels and 1%.

1.3.3 Performance of Board Turnover Events

Next, we perform an event study to assess how the market values board turnover events around activism campaigns, and whether the characteristics of directors that leave the board or newly join the board matter for their announcement returns. We calculate cumulative abnormal returns over the event windows 0, [-1,+1], [-3,+3], and [-5,+5], centered on the campaign announcement date. We obtain abnormal returns as the difference between the actual return and the predicted return from a CAPM beta estimate using 150 trading days prior to the event window.

Panel A of Table (1.5) summarizes the abnormal, which are consistently positive and significant for both exit events and entry events during the campaign. In contrast, before the campaign director appointments are associated either with insignificant or even negative announcement returns. For board appointments (entries), the announcement returns after activism are significantly positive across all event windows, for the [-5, +5] window they are 1%. In contrast, pre-campaign entries for the same window are insignificant at 0.2%. The difference in announcement returns between campaign and pre-campaign entries is positive and statistically significant across all event windows.

For exits, announcement returns during activist campaigns are also significantly positive at 0.92% for the [-5, +5] window, whereas pre-campaign exits generate negative or insignificant returns. The difference between post- and pre-campaign exits is substantial, with a significant positive difference across all event windows.

These results suggest that the market values both new board appointments and exits following activist engagement as beneficial.

Panel B in Table (1.5) extends this analysis by considering the individual characteristics of board members, using the same abnormal returns, for the [-3,+3] window. For

entries during campaigns, directors with financial expertise and MBA degrees are associated with slightly lower CARs, while for exits, the departure of directors from the nominating/governance committee yields positive market reactions. However, most characteristics—including age, gender, tenure, education, co-opted and committee roles—do not significantly affect returns. The results show that the inclusion of these characteristics does not alter the CARs in a meaningful way, suggesting that shareholders react primarily to the presence of hedge fund activism, rather than to specific attributes of the board members. Overall, these findings highlight the central role of hedge fund activism in driving shareholder value and board changes, rather than the inherent characteristics of the directors themselves.

1.3.4 Career Dynamics of Board Appointments and Exits

We now turn from the number of directors activists add or remove to the length of time long those directors stay and what happens to them afterwards. Table (1.6) reports four complementary pieces of evidence on the board-appointment life cycle.

Panel A shows a univariate comparison of the half-life—the average time until exit—for the 4,467 directors who join boards within six months of the start of an activist campaign, either in a target or a matched firm. Whether we treat right-censored spells as completed ("censored = exit") or drop them altogether, activist appointees leave significantly sooner than their counterparts on matched boards: the gap is about 1.6 years (3.65 vs. 5.27 years when censored spells are treated as exits; 2.89 vs. 4.44 years when they are excluded). Two-sample t-tests confirm statistical significance.

Panel B formalises this result with Cox proportional-hazards regressions. Across four specifications, the Target indicator carries a hazard ratio around 1.36—implying a 35–37% higher risk of departure for activist-appointed directors at any tenure length. Among the control variables, female directors enjoy greater staying power (hazard of 0.69), as do

Table 1.5: Performance of Board Turnover Events

Panel A: Announcement returns for board entries and exits						
		Entry			Exit	
Event Window	During	Before	Diff	During	Before	Diff
0	0.395***	0.107	0.288**	0.224**	-0.637***	0.862***
	(0.070)	(0.111)	(0.126)	(0.091)	(0.177)	(0.181)
$[-1,+1]$	0.510***	-0.434*	0.944***	0.678***	-0.693**	1.371***
	(0.124)	(0.248)	(0.248)	(0.161)	(0.314)	(0.320)
$[-3,+3]$	0.828***	0.187	0.641*	0.584**	-0.934*	1.519***
	(0.182)	(0.394)	(0.381)	(0.241)	(0.496)	(0.496)
$[-5,+5]$	1.005***	0.240	0.765*	0.918***	-0.453	1.371***
	(0.212)	(0.422)	(0.424)	(0.276)	(0.588)	(0.580)
Observations	4,016	2,111	6,127	2,675	1,640	4,315

Panel B: Announcement returns by director characteristics				
Event Window		CAR [-3,+3]		
	Entry-During	Entry-Before	Exit-During	Exit-Before
Audit Committee	0.476	-5.582	0.332	-1.638
	(1.943)	(4.156)	(0.533)	(1.150)
Compensation Committee	0.845	-4.766	0.510	-0.001
	(1.594)	(3.495)	(0.528)	(1.070)
Nom./Gov. Committee	-0.798	-7.567*	1.158**	-1.620
	(1.611)	(4.012)	(0.516)	(1.057)
Board Chair / Lead Director	0.227	1.071	1.002	-0.447
	(0.751)	(1.574)	(0.983)	(1.889)
Co-opted Director			-0.771	-0.318
			(0.552)	(1.132)
Age	-0.026	-0.048	-0.009	-0.031
	(0.016)	(0.038)	(0.024)	(0.042)
Tenure			0.033	-0.107
			(0.035)	(0.067)
Female	0.364	-1.015	-0.764	-2.509
	(0.530)	(0.991)	(0.749)	(2.089)
Education: Undergraduate	-0.571	0.392	-0.581	2.621
	(1.014)	(1.523)	(0.835)	(1.737)
Education: Graduate	0.261	0.782	-0.019	2.352*
	(0.491)	(0.949)	(0.588)	(1.356)
Education: MBA	-0.664*	-0.064	0.289	0.697
	(0.391)	(0.913)	(0.540)	(1.106)
Observations	3,501	1,863	2,407	1,507

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

The table reports cumulative abnormal returns around board turnover events. Events include non-executive board members who enter or exit the board within a 6-month period, during and before the campaign announcement date. Activist campaigns are included if both target and matched firms experience at least one exit and one entry within 6 months following the activist campaign announcement date. The sample includes 4,016 individual board members that enter after activist campaigns and 2,675 that exit. Panel B shows how director characteristics influence cumulative abnormal returns (CARs) during board turnover events in the [-3,+3] window, for entries and exits occurring during or before the activist campaign announcement.

older directors when modelled linearly (hazard < 1), yet those above 65 display an elevated hazard of 1.22, suggesting a curvilinear age effect. Holding the chair/lead-director role significantly lengthens tenure (hazard of 0.80). These multivariate estimate show that board appointments during activist campaigns, controlling for other observable characteristics, appear like a task force: they are brought in to execute a specific agenda, likely that of the activist, and are less likely to achieve long tenure.

Next, we turn to board members that leave the board in the wake of activism in Panel C. For all board members that exit, at target and matched firms, we compare the percentage that reappear in a board position in a listed firm elsewhere at any time (until 2024), and for this conditional sample the waiting time until the new appointment. Roughly one-third of all board exits obtain a new board seat elsewhere, and the waiting time to the next appointment is statistically indistinguishable between groups at 2.6 years, suggesting that there is no impact on the career path of directors that exit a board in the wake of an activist campaign.

Finally, Panel D estimates Cox models for the time until a new appointment. Consistent with the univariate results in Panel C, the Treat coefficient is never significant (hazard of 1.02), confirming that activists neither accelerate nor impede a departing director's redeployment.

Taken together, Table (1.6) shows that hedge-fund interventions compress the tenure distribution on both ends: new appointments turn over more quickly, yet the external director labour market absorbs these shifts smoothly. These patterns reinforce our earlier conclusion that activism's governance value stems less from installing "superstar" directors and more from the disciplinary turnover mechanism itself: the credible threat of replacement and the resulting accountability pressure on the board as a whole.

The table reports two types of board appointment dynamics: (i) new entries who later exit,

and (ii) exits who later join a different board. New entries and exits are defined as board members appointed or leaving within six months of the campaign announcement. Panel A reports the average half-life of new entries in targeted (Target) and matched (Control) firms, considering two approaches: (i) treating directors still in position at the end of our sample period (January 2024) as exits, and (ii) excluding censored observations. Panel B reports hazard ratios from Cox proportional hazards regressions where the dependent variable is tenure of the new entries from Panel A, for targeted and matched firms. The models use alternative specifications of director age, linear, log-transformed, and age>65, controlling for director characteristics. Standard errors are clustered at the director level. Panel C reports (i) the average tenure at time of exit, (ii) the percentage of exited directors that within our sample period gained any new appointment in a different board position elsewhere, and (iii) the average waiting time between exit date of those directors and their new appointment, in targeted (Target) and matched (Control) firms. Panel D reports hazard ratios from Cox proportional hazards regressions where the dependent variable is waiting time until earliest new appointment of the exits from Panel C, for targeted and matched firms.

Table 1.6: Career Paths of Board Entries and Exits Following Activism

Panel A: Half-Life of Board Entries				
	Censored as Exits		Censored Excluded	
	Target	Matched	Target	Matched
Duration of position	3.65	5.27	2.89	4.44
Difference	-1.62 (t=12.23)		-1.55 (t=11.5)	
Observations	3,352	1,115	2,446	801
Panel B: Cox Proportional Hazards Models of Board Entries				
	(1)	(2)	(3)	(4)
Target	1.365***	1.361***	1.370***	1.348***
	(0.059)	(0.059)	(0.059)	(0.058)
Female	0.684***	0.685***	0.687***	0.691***
	(0.046)	(0.046)	(0.046)	(0.046)
Bachelor	1.111	1.110	1.139	1.115
	(0.104)	(0.104)	(0.106)	(0.105)
Master	0.946	0.947	0.928	0.940
	(0.056)	(0.056)	(0.054)	(0.056)
MBA	0.964	0.965	0.970	0.973
	(0.043)	(0.043)	(0.043)	(0.043)
Compensation	1.121	1.125	1.085	1.099
	(0.372)	(0.374)	(0.370)	(0.382)
Nominating	0.824	0.823	0.798	0.791
	(0.246)	(0.245)	(0.241)	(0.238)
Audit	1.113	1.117	1.065	1.097
	(0.358)	(0.359)	(0.354)	(0.370)

Co-opted	1.026	1.055	0.932	1.068
	(0.054)	(0.062)	(0.043)	(0.065)
Lead Chair	0.801***	0.803***	0.789***	0.801***
	(0.050)	(0.050)	(0.048)	(0.049)
Age	0.995**			0.990***
	(0.002)			(0.002)
Log Age		0.746***		
		(0.079)		
Age > 65			1.223***	1.448***
			(0.091)	(0.0125)
Observations	4,467	4,467	4,467	4,467

Panel C: Board Exits and Re-Appointments

	Target	Matched	Diff	t-test
Appointed elsewhere (%)	0.34	0.32	—	—
Waiting time (years)	2.59	2.64	-0.05	-0.33
Observations	3,485	1,587	—	—

Panel D: Cox Models for Re-Appointment Timing

	(1)	(2)	(3)	(4)
Target	1.019	1.017	1.032	1.014
	(0.058)	(0.058)	(0.059)	(0.059)
Age	1.018***			1.021***
	(0.003)			(0.004)
Female	1.252***	1.240***	1.222**	1.233***
	(0.098)	(0.097)	(0.100)	(0.097)
Bachelor	1.082	1.090	1.091	1.093

	(0.143)	(0.145)	(0.146)	(0.146)
Master	0.933	0.929	0.949	0.930
	(0.064)	(0.064)	(0.064)	(0.064)
MBA	1.031	1.029	1.000	1.025
	(0.060)	(0.060)	(0.058)	(0.060)
PhD	0.890	0.888	0.918	0.891
	(0.084)	(0.084)	(0.088)	(0.084)
Compensation	0.885**	0.884**	0.903*	0.882**
	(0.049)	(0.049)	(0.050)	(0.049)
Nominating	0.985	0.985	1.019	0.988
	(0.056)	(0.056)	(0.058)	(0.056)
Audit	1.009	1.004	1.055	1.006
	(0.057)	(0.057)	(0.060)	(0.057)
Co-opted	0.239***	0.243***	0.251***	0.243***
	(0.021)	(0.021)	(0.022)	(0.021)
Chair/Lead	1.115	1.112	1.181*	1.114
	(0.106)	(0.106)	(0.109)	(0.107)
Log Age		2.525***		
		(0.394)		
Age > 65			1.165*	0.853
			(0.091)	(0.085)
Observations	1,617	1,617	1,617	1,617

1.4 Conclusion

This study investigates the impact of hedge fund activism on board turnover, board characteristics, and stock market reactions to board changes in targeted firms. Using a comprehensive dataset from 1994 to 2024, we observe increased board turnover in target firms, driven both by higher entry rates of new directors and spiking exit rates of incumbents. Our analysis quantifies the effort by activists to expand boards, bringing in directors aligned with their objectives, while replacing board members that plausibly can be targeted. The effects of these turnover events on board characteristics are weak, highlighting that while activists plausibly prioritize certain director characteristics in their lobbying, their goal is to make the board more resceptive to their demands, not implement skill changes. The stock market responds positively to board turnover events following activist campaigns, with stronger reactions to exits than entries. This reflects investor confidence in activist-driven board changes, particularly the removal of directors perceived as barriers to strategic change. The difference in CARs between post- and pre-campaign board changes is significant, reinforcing the idea that market participants view activist-induced turnover as value-enhancing.

1.5 Appendices

Variable Definitions

Table 1.7: Activist Campaign Variables

Variable	Description	Source
Initial disclosure date	Earliest disclosed date of the activist campaign, through regulatory filing or voluntary disclosure	Brav et al, Diligent

Table 1.8: Board Member Characteristics

Variable	Description	Source
Board chair/Lead director	Indicates the COB position, or a board position designated as lead director or presiding director	BoardEx
Audit committee	Indicates membership of the audit committee	BoardEx
Compensation committee	Indicates membership of the compensation committee	BoardEx
Nom./Gov. committee	Indicates membership of the nominating/corporate governance committee	BoardEx
Education: Undergraduate	Indicates that the director has an undergraduate degree	BoardEx
Education: Graduate	Indicates that the director has a graduate degree	BoardEx
Education: MBA	Indicates that the director has an MBA	BoardEx
Co-opted director	Indicates whether a director joined after the current CEO or not, based on director tenure	BoardEx
Outside director	Indicates that the director is independent	BoardEx
Age	Director's age	BoardEx
Female	Indicates that the director is female	BoardEx
Tenure	Indicates the number of years that the director served on a particular board. When unavailable, we assume that tenure starts with the first observation in our sample.	BoardEx

Table 1.9: Board Member Skills

Variable	**Description**	**Source**
Skills: Academic	The director is from academia or has a higher degree (such as a Ph.D.)	BoardEx, CapitalIQ, OpenAI
Skills: Company business	The director is experienced in the firm's business or industry (or a closely related industry)	BoardEx, CapitalIQ, OpenAI
Skills: Compensation	The director has compensation and benefits experience	BoardEx, CapitalIQ, OpenAI
Skills: Entrepreneurial	The director has entrepreneurial experience	BoardEx, CapitalIQ, OpenAI
Skills: Finance/accounting	The director has experience in banking, finance, accounting, or economics-related activities	BoardEx, CapitalIQ, OpenAI
Skills: Governance	The director has corporate governance experience	BoardEx, CapitalIQ, OpenAI
Skills: Government/policy	The director has governmental, policy, or regulatory experience	BoardEx, CapitalIQ, OpenAI
Skills: International	The director has international experience	BoardEx, CapitalIQ, OpenAI
Skills: Leadership	The director has leadership skills/experience	BoardEx, CapitalIQ, OpenAI
Skills: Legal	The director has legal expertise	BoardEx, CapitalIQ, OpenAI
Skills: Management	The director has management and communications skills/experience	BoardEx, CapitalIQ, OpenAI
Skills: Manufacturing	The director has manufacturing experience	BoardEx, CapitalIQ, OpenAI
Skills: Marketing	The director has marketing and sales skills/experience or knowledge in marketing activities	BoardEx, CapitalIQ, OpenAI
Skills: Outside board	The director has outside board experience	BoardEx, CapitalIQ, OpenAI
Skills: Outside executive	The director is an executive of another company	BoardEx, CapitalIQ, OpenAI
Skills: Risk management	The director has risk management experience	BoardEx, CapitalIQ, OpenAI
Skills: Scientific/R&D	The director has engineering, scientific, or research & development (R&D) skills/experience	BoardEx, CapitalIQ, OpenAI
Skills: Strategic planning	The director has strategy skills or strategic planning experience	BoardEx, CapitalIQ, OpenAI
Skills: Sustainability	The director has experience in environmental and sustainability issues	BoardEx, CapitalIQ, OpenAI
Skills: Technology	The director has technology skills/experience	BoardEx, CapitalIQ, OpenAI

Table 1.10: Firm Characteristics

Variable	**Description**	**Source**
Total asset	Book assets of the firm	COMPUSTAT
Log(Market Cap)	Log of firm's market capitalization	CRSP
Book-to-market	The market value of equity divided by the book value of equity and deferred taxes	COMPUSTAT
Growth	The percentage change in revenue or total assets compared to the previous year	COMPUSTAT
ROA	Return on Assets, calculated as net income divided by total assets, representing the efficiency of the firm in using its assets to generate earnings	COMPUSTAT
Cash flow	Cash flow from operations, indicating the amount of cash generated by the firm's normal business operations	COMPUSTAT
Div. yield	Dividend yield, calculated as dividends per share divided by the stock price, representing the return an investor receives from dividends relative to the stock price	COMPUSTAT
Leverage	The ratio of total debt to total assets, measuring the extent of a firm's financial obligations compared to its assets	COMPUSTAT
Board Size	The total number of directors serving on the board of the firm	BoardEx
Outsiders share	The proportion of independent (outside) directors on the board, calculated as the number of independent directors divided by the total board size	BoardEx
Avg. age	The average age of directors serving on the board	BoardEx
Avg. tenure	The average tenure (in years) of directors serving on the board	BoardEx
Female share	The proportion of female directors on the board, calculated as the number of female directors divided by the total board size	BoardEx
Finance exp. share	The proportion of directors with financial experience on the board, calculated as the number of directors with financial expertise divided by the total board size	BoardEx

Table 1.11: How Activist Hedge Funds Select Targets

	(1)	(2)	(3)	(4)
Log(Market cap)	-0.067**	-0.067**	-0.117***	-0.119***
	(0.00027)	(0.00027)	(0.00031)	(0.00031)
Book-to-market	0.059**	0.057*	0.056**	0.055*
	(0.00030)	(0.00029)	(0.00029)	(0.00028)
Growth		-0.030	-0.030	-0.030
		(0.00030)	(0.00030)	(0.00030)
ROA	-2.204***	-2.879***	-2.567***	-2.535***
	(0.00737)	(0.00852)	(0.00851)	(0.00849)
Cash flow		0.660	0.675	0.681
		(0.00451)	(0.00451)	(0.00448)
Div. yield		1.077	1.112	1.099
		(0.00831)	(0.00825)	(0.00825)
Board Size			0.076***	0.069***
			(0.00024)	(0.00024)
Avg. Age			0.022**	0.022**
			(0.00009)	(0.00009)
Avg. tenure			-0.047***	-0.059***
			(0.00015)	(0.00015)
Avg. Co-opted				-0.416***
				(0.00132)
Observations	138,308	138,308	138,308	138,308
Quarter FE	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

This table reports the determinants of being targeted by activist hedge funds, estimated in probit regressions. The dependent variable is whether a hedge fund activist targets the firm in a given quarter. The sample is all campaigns and their matched firms quarterly since 1994 to 2024. All right-hand-side variables are lagged by one year. The coefficients represent marginal effects expressed as percentages, evaluated at the mean. Standard errors are clustered at the firm level and reported in parentheses. *, ** and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

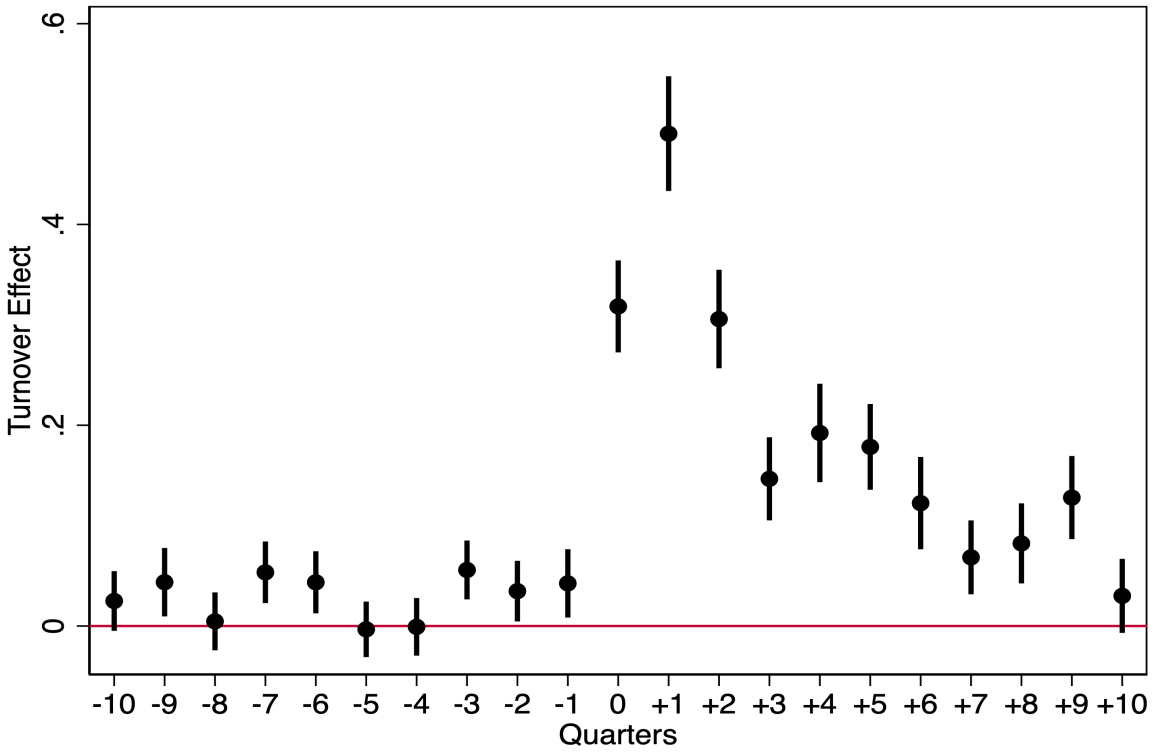

Figure 1.3: Parallel Trends

Note: The chart illustrates the parallel trends between targeted (treatment) firms and matched (control) firms prior to the activism campaign, indicating no significant differences between the two groups before the campaign date. However, immediately following the campaign, a sharp increase in turnover is observed for the targeted firms over the subsequent two quarters. This difference stabilizes at a higher positive level and remains significant through quarter 9, suggesting that targeted firms experience consistently higher turnover than their matched counterparts following the campaign.

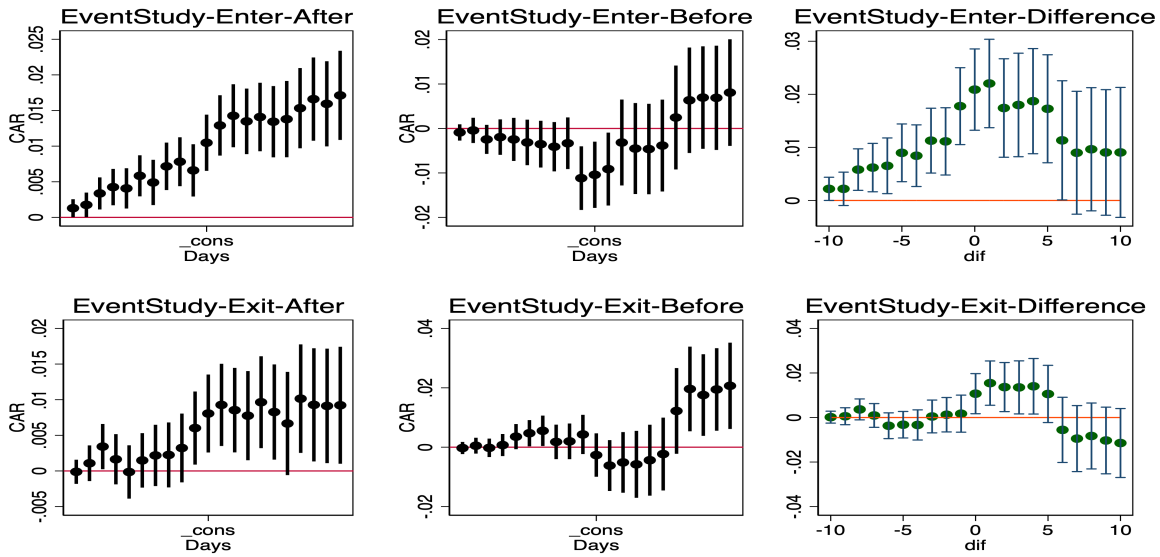

Figure 1.4: Event Study

Note: This figure presents six panels showing the CARs from -10 to +10 days around board entries and exits. The top row illustrates CARs for entries after campaigns (top left), before campaigns (top middle), and the difference between post- and pre-campaign entries (top right). The bottom row shows CARs for exits after campaigns (bottom left), before campaigns (bottom middle), and the difference between post- and pre-campaign exits (bottom right). The results indicate stronger positive market reactions to board changes induced by activism compared to similar changes before campaigns.

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Chapter 2

Metro Station Inauguration and Housing Prices[1]

2.1 Introduction

Public transportation in large cities and metropolitan areas is of paramount importance, and therefore are policies regarding its creation and expansion. While the transportation corridors can bring some disadvantages to residents adjacent to them, e.g., crowding and pollution, they are mainly perceived as advantageous because they make the area more accessible and easier for daily commutes. Therefore, it is expected that nearby housing prices to increase due to more and faster access to other regions of the city. In this study, we not only measure this effect but also examine factors that determine its magnitude.

Our unique administrative data comes from Tehran, and we consider the total number of 1,336,266 transactions. Tehran is the capital and biggest city of Iran and home to about

[1]This chapter is based on the paper "Metro Station Inauguration, Housing Prices, and Transportation Accessibility: The Case of Tehran," coauthored with Masoud Talebian and Hosein Joshaghani, and published in the Journal of Transport and Land Use.

10 million population. Tehran is quite a heterogeneous city regarding income and wealth, and housing prices range from less than $300 to $10,000 per square meters.

The first metro line in Tehran was launched at 1999, and it currently includes 5 operational lines and 105 stations, 20 of which are interchange stations. As noted by Railway-Technology.com (2014),Tehran Metro currently ranks fifth in Asia and is planned to have 9 lines once all construction is completed by 2020. (Tehran Metro, 2014) It is mostly underground, runs from 5:30 to 23:00 all weekdays, and transports about 2.5 million passengers daily. The total length of the metro is 120km, where the longest one is Line 1 with a length of 28 kilometers.

It is worth mentioning that the housing prices have not only been affected by metro stations but by many other factors. To overcome this difficulty, we use difference-in-difference method by building treatment and control groups. As known, the difference-in-differences methodology can identify the *causal* effect of the new metro service, as opposed to describing simply correlations.

We use parametric estimation methods, using station proximity as a distance category measure. We treat neighborhood characteristics as a single dummy variable, similar to Bajic (1983) and many other papers. We apply Euclidean distance and use 400 meters as a threshold as it indicates a walking distance neighborhood (Hu et al. (2019)), about 5-minute walking distance[2].

The location of metro station is important because of income rate of households living around, as well as the extent and quality of public transportation available in the area varies geographically. Richness of our administrative data, and our identification strategy, make it possible to investigate the effect of bus and train as substitute modes of public transportation. We examine whether and to what extent the effect of metro stations is

[2]In the online appendix, for robustness check, we investigate 300, 400, 500 and 600 meters as the threshold. Results remains both qualitatively and quantitatively the same.

different in comparison to already existing rapid buses relative to areas with less access to public transport. Also, it can help us to understand if the increase in prices close to metro station is due to a better transportation or there are other factors affecting it. To investigate the issue, we categorize stations based on whether there already exist public transportation or not.

Urban policies create externalities which are usually hard to measure, and we believe our study can shed some light on policy evaluation based on evidence. More specifically, the change in market prices for properties with good access to stations can be a proxy for the value of metro. While metro fares have been constant, the costs have increased, and the government and municipal funds are not enough to support it; this situation is not limited to Iran, Diao (2015) reports that government subsidies reached US$35.4 billion in 2006 in the United States.

Rest of the paper is as follows. Related literature is reviewed in chapter 2. All data used in this paper is thoroughly introduced in chapter 3. For interested readers, more sophisticated detail about our data is presented in appendix A of the paper. In chapter 4 we present our methodology to control for the confounding factors. Then, in chapter 5 we present our results and chapter 6 concludes.

2.2 Literature Review

Transportation can affect the form of cities and their built environment, we refer to Badoe and Miller (2000) for a survey. There exists a vast scientific literature about the factors affecting housing prices, applying quantitative and qualitative methods. This effect is one of the key aspects examined in the creation of transport passages, in particular railways and stations, in cities. Transport passages affect housing prices through two main factors: 1) easier access which is positive and 2) disturbance, noise, crime rates, and pollution

which is negative. The after-mentioned studies focus on these two effects, estimating which effect is dominant.

There are two early reviews of the empirical research about land property values and transportation facilities. Vessali (1996) finds that the impact of rapid transit on property value is about 6-7%. Ryan (1999) discusses the existing inconsistency in results about how transport is connected to land-use and housing prices, which may be due to the complexity of metropolitan development and unpredictable travel patterns.

Most studies indicate that a shorter distance from houses to metro stations will lead to an increase in the prices. Chen et al. (1998) study Portland and show that property value decreased at the rate of $32.30 per meter away from the station. It implies that the positive effect dominates the negative effect, which implies a declining price gradient as one moves away from *light rail train* (LRT) stations for several hundred meters. Murat Celik and Yankaya (2006) found that the proximity to rail stations in Izmir, Turkey was valued at $250-300 per meters, and the value of per hour closer to the station was $1.47-1.83 on average in every travel. Hess and Almeida (2007) estimated that in the study area in Buffalo New York, every foot closer to a light rail station increases average property values by $2.31. Consequently, a home located within one-quarter of a mile radius of a LRT station can earn a premium of $1300–3000, or 2–5 per cent of the city's median home value.

Some other papers denote that the effect of new metro stations on residential property value is generally positive. Bajic (1983) studied the new Spandina subway development in Toronto and found a positive effect which can be attributed to the time taken by public transport from the property to the downtown. He concluded that the direct savings in commuting costs have been capitalized into housing values. McMillen and McDonald (2004) examined the effect of the new rapid transit line from downtown Chicago to Mid-

way Airport on single-family house prices before and after the opening of the line. The difference between the increases in the value of houses within the sample area as compared with houses farther away from the new transit stations was approximately $216 million between 1986 and 1999. Coffman and Gregson (1998) also checked out the same test in the Knox County, Illinois and the result was the land in close proximity to new railroads became more valuable because of decreased transportation costs. Diao et al. (2017) examined the effects of metro station construction on residential property prices in Singapore. In this important paper, unlike other articles, the network distance was used instead of Euclidean distance. Because the presence of rivers and highways in the city of Singapore, network distance of two points may be quite different compared to their Euclidean distance. The result of the model used on the Singapore data indicates that homes located less than 600 meters in the metro station experienced a price increase of 8.6% compared to other homes. Wu et al. (2015) uses a spatial multi-intervention difference-in-difference method to investigate the opening and planning impacts of transport improvements on land markets. The result in a mega-city of China shows that residential and commercial land parcels receiving increased station proximity have experienced appreciable price premiums. Chica-Olmo et al. (2019) applied hedonic regression to study the effect of proximity to freight trains on real state. The results of Debrezion et al. (2011) from studying cities in Netherlands also support that proximity to train stations increases the property value, although they report some negative effects of train proximity due to noise nuisance.

More recent papers show that public transport is characterized as less important for higher price segments, or segments with already good access to public transportation. Bohman and Nilsson (2016) investigated the observations in Scania, Sweden, and showed that the price effect of proximity to a commuter train station was strongest in lower price segments of the housing market in comparison to higher price segments. Sun et al. (2016)

in Tianjin, China, concluded that the construction of subway lines had a greater impact on marginal zones of the city than on the city's downtown area because of the extent and quality of public transportation available in those areas.

Regarding Tehran, Forouhar and Hasankhani (2018) investigated whether the effects of the metro station to the residential properties are different in higher income districts and lower income districts. They explored the effect of opening 6 metro stations on housing prices, where three were in high-income prosperous regions and the other three were in low-income deprived regions. Using only 30 transactions per year for each of those 6 stations (and total of 2,160 observations), they claim that after opening the metro station in the high-income areas, property prices around the metro station will fall in price, while it rises in low-income areas.

Even though most of the papers estimate that the impact of new rapid rail transportation on housing price is positive, but some of the researches show that this impact is negative or insignificant when the property is very close to the stations. Diao et al. (2016) found that removal of train noise externalities increases housing prices in the affected area by 13.7% on average after the cessation period of the KTM railway services in Singapore. The average prices for houses located within a 400-m boundary from the railway lines increased by 3.5% relative to prices for houses located outside the 400-m boundary after the cessation agreement has been announced. Mohammad et al. (2015) estimated that the effect of the newly operated Dubai Metro on the sale transaction value of residential properties was about -9% within 0.5km of a station because of noise and pollution from the transport system.

Ransom (2018) implements the same type of analysis, i.e., difference-in-difference regression technique, as ours in a very similar research question to study the effect of light rail transit service. Their results suggest no significant value added by the light rail services to

the residential neighborhoods in Seattle, Washington. Billings (2011) for Charlotte, North Carolina, also found that the impact of the LRT on the value of residential properties was not significant within 0.8 kilometer. Bowes and Ihlanfeldt (2001) investigated this effect in Atlanta, Georgia and found that houses that are very close to stations were affected by negative externalities emitted by stations and the access to neighborhoods that stations provide to criminals, but those at further distance were beyond the externality effects and benefited from the transportation, like access provided by the stations, reducing commuting costs or by attracting retail activity to the neighborhood. Their result showed that properties within a 500m from a rail station are 19% cheaper than properties beyond 5km from a station. Giuliano (2004) studied the effect of San Francisco rail transit system (BART) on urban form and found out that it did not have much an effect, and it was not an important factor in the location decision of employers. Forrest et al. (1996) studied the effect of rail services on house prices in Manchester and found a significant negative effect.

In one of the few studies conducted on commercial properties, Mohammad et al. (2015) estimated the effect of the newly operated Dubai Metro on the sale transaction value of residential and commercial properties. These estimates showed a positive effect of the metro on sale values of both residential and commercial properties, although the effect was stronger for commercial properties. Baker (1983) studied the relationship between land development and train station and found out that 54% of non-residential construction occurred close to train station in Washington DC in period of 1979-1982. In a state-of-the-art paper, Pope and Pope (2015) study the effect of Walmart opening on housing prices, and their estimates suggest that a new store increases nearby housing prices.

On the other hand, transportation including metro railway or Bus Rapid Transit (BRT) can have a widespread effect on the other urban amenities. Stewart et al. (2017) investigate the causal effect of Bus Rapid Transit (BRT) on changes in transit ridership. The

result denote that Ridership increased by 35% along routes where BRT was implemented from 2010 to 2013 compared to routes that maintained conventional bus service. Yang et al. (2019) study the effect of bus accessibility on property prices in Ximen, China and conclude that access to bus stop is positively correlated with property prices.

On the methodological perspective, while this paper and most of the papers in this literature use reduced form techniques for estimation, a recent line of research addresses the spatial structure of cities directly with formal, structural models. Bryan et al. (2019) reviews benefits of such models in the far more fluid cities of developing world.

2.3 Data

Three categories of data are required to investigate the effect of the inauguration of the metro station on housing prices: *i*) housing prices; *ii*) metro stations and their inauguration date; *iii*) postal codes and geographical coordinates. Each category is described in detail.

2.3.1 Housing Prices

Data on housing prices are according to the recorded transactions, obtained from the Office of Planning and Housing Economy (OPHE) of the Ministry of Roads and Urban Development in Iran. This administrative information includes complete data on all individual housing transactions from April 1, 2010, to December 20, 2018 (nine years) in Iran. We focus on part of data which is for the residential housing transaction in Tehran, which consists of almost 1,260,000 housing sale transactions. All real estate transactions in Iran are done by real estate agencies. These transactions must be fully integrated into a system connected with the Ministry of Roads and Urban Development. The system has been in operation throughout the country since 2010. The information recorded

within the system is provided by real estate managers. OPHE record all the housing transaction information which are officially registered in real estate agencies since 2010[3]. We refer to Appendix 2 for data cleaning steps. For each transaction, the OPHE data has the following variables, and the summary statistics is reported in Table (2.1). The description of the time categories is presented in the appendix.

1. Transaction code,
2. The transaction dates,
3. Total transaction price,
4. The price per square meter,
5. The area of the house,
6. Age of the building,
7. Using type of the building,
8. Frame type of the building skeleton,
9. The first six digits of the ten digits postal code of the housing traded,
10. Percentage of the property traded.

The using type of the building in our administrative data is divided in 4 categories: *i*) Residential Buildings *ii*) Commercial Buildings *iii*) Institutions *iv*) Office Buildings. More than 99% of these transactions are residential houses. In this research, we calculate the impact of metro station inauguration on residential houses and omit the other types of building which are less than 1%. As shown in the Table (2.2), the skeleton is mostly made of concrete, metal or both. Only less than 1% of skeleton properties are different.

[3]The housing information used in this article is available in the following link: https://bit.ly/2IteOEz

Table 2.1: Summary statistics of variables

	Total		Treatment		Control	
	mean	sd	mean	sd	mean	sd
Area	84.93	38.30	76.58	33.41	84.89	40.56
Price (Mill. Tomans)	4.24	3.48	3.66	2.74	4.25	3.49
Price (Dollars)	1000.95	613.69	881.19	501.85	1007.79	628.66
Age	8.82	8.59	10.12	9.37	9.08	9.02
Observations	1267466		66324		766958	

Note: This table shows the summary statistics for area, price (in local currency and dollars), and age of the houses. Observations are split between treatment and control groups. USD/IRR changes in different years. In 2010 each Dollar was averagely 1100 Tomans and in 2019 it grows up to 12000 Tomans in the market. Prices are nominal and are not adjusted for inflation.

Residential properties in Iran and Tehran are one or more units in one building, each unit having one household and owner. In this situation, several families may live in one apartment. There are, of course, single-unit duplex houses that are very few. Each residential property in Iran is divided into 6 shares, where any real or legal person can own one or more of these shares, but generally one person owns all 6 shares. At the time of trading, any of these shares can be traded. As a result, 16% ,33% ,50% ,67% ,84% and 100% of a property may be traded on each transaction. In the administrative OPHE data, the number of transactions that is traded less than 100% of the house is only 1.7%, so they are omitted from our study.

2.3.2 Metro Stations

The metro stations data has been obtained from Tehran Metro Operations Company. This information includes:

1. Time of the inauguration of the metro station,

2. Geographic coordinates of the metro station,

3. Name of the metro station,

Table 2.2: Distribution of Frame Types

Frame Type	**Count**	**Col %**	**Cum %**
Concrete	609,141	48.1	48.1
Steel	584,520	46.1	94.2
Steel and Concrete	69,396	5.5	99.7
Without Frame	2,738	0.2	99.9
Brick or Cement Block	1,091	0.1	100.0
Wood	317	0.0	100.0
Adobe or Clay	262	0.0	100.0
Total	**1,267,466**	**100.0**	

Note: This table shows the distribution of houses'frame type. More than 99 percent of frame types are concrete or/and metal.

4. The number of metro lines which passes through the station.

The total number of stations operated in Tehran is 105, which is planned to increase up to 150 stations by 2022. The number of stations opened during the period considered in this study is presented in Figure (2.1). The red lines specify the stations opened within our research period.

As will be discussed further, we use difference-in-difference method to investigate the causal effect of a metro station inauguration on residential housing prices. To implement this method, it is necessary to have access to the data before and after the inauguration of the metro station. Based on the availability of housing prices from April 1, 2010, only those stations inaugurated after this date have been investigated. Therefore, 45 stations are investigated, most of which are related to stations of lines C and D.

It is important to mention that four of these stations (A1, A8, B9, D1) have been inaugurated two times because they are the junctions of two different metro lines. These stations opened for the first time before the period under investigation, and for the second time within our research period. Since the second opening of metro station can have a different impact from the first opening, we produce two different outputs: with and without these

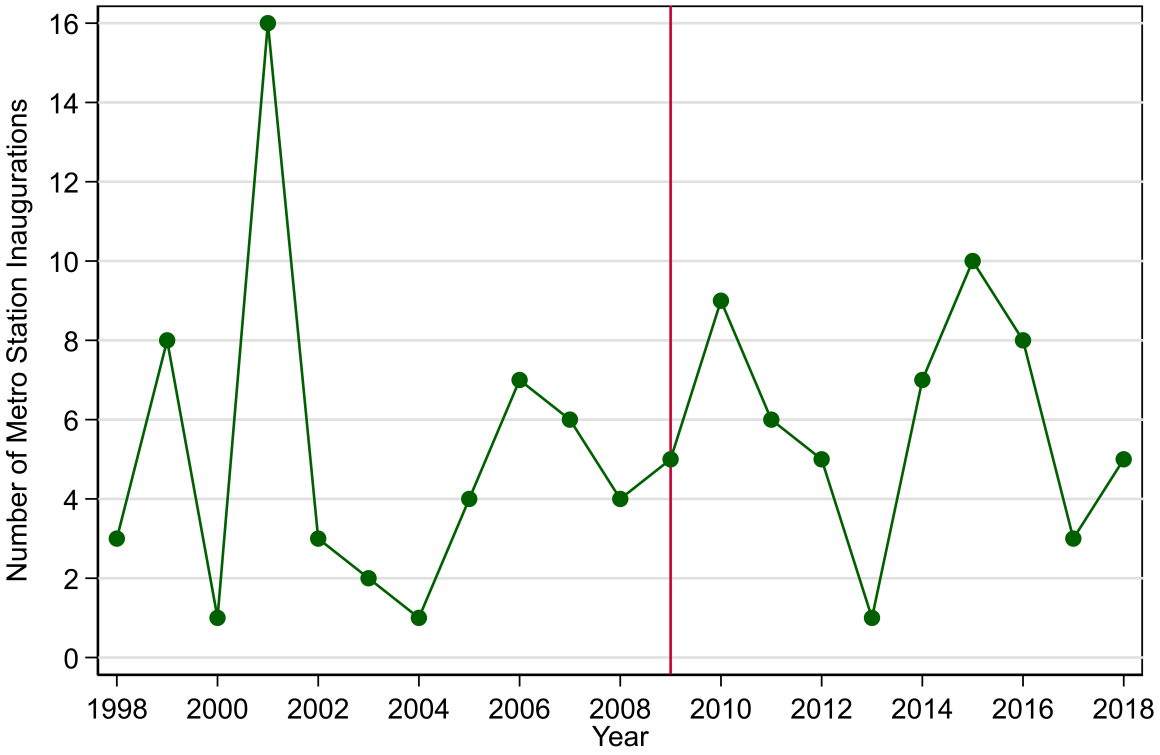

Figure 2.1: Number of inaugurated stations per year in Tehran since 1998

Note: The vertical line in 2009 depicts the earliest transaction that is recorded in OPHE administrative data. Source: Reported by Tehran Metro Operations Company.

stations. Location of these 45 stations investigated is depicted on Figure (2.2).

2.3.3 Postal Codes and Geographic Coordinates

In Iran, each property has a unique 10-digit postal code that not only identifies the city and neighborhood of the property but also its exact geographic coordinates. Postal code in Tehran begins with numbers 11 to 19 (excluding 12). According to the first three digits of the postal code, the city of Tehran is divided into 65 regions. The first five and six digits of the postal code, the city of Tehran is divided into 1,877 and 15,016 parts respectively.

Polygons created by the first 5 digits of the postal code are visible on map of Tehran city in Figure (2.2) and (2.3). Figure (2.3) represents the average price of housing in each of

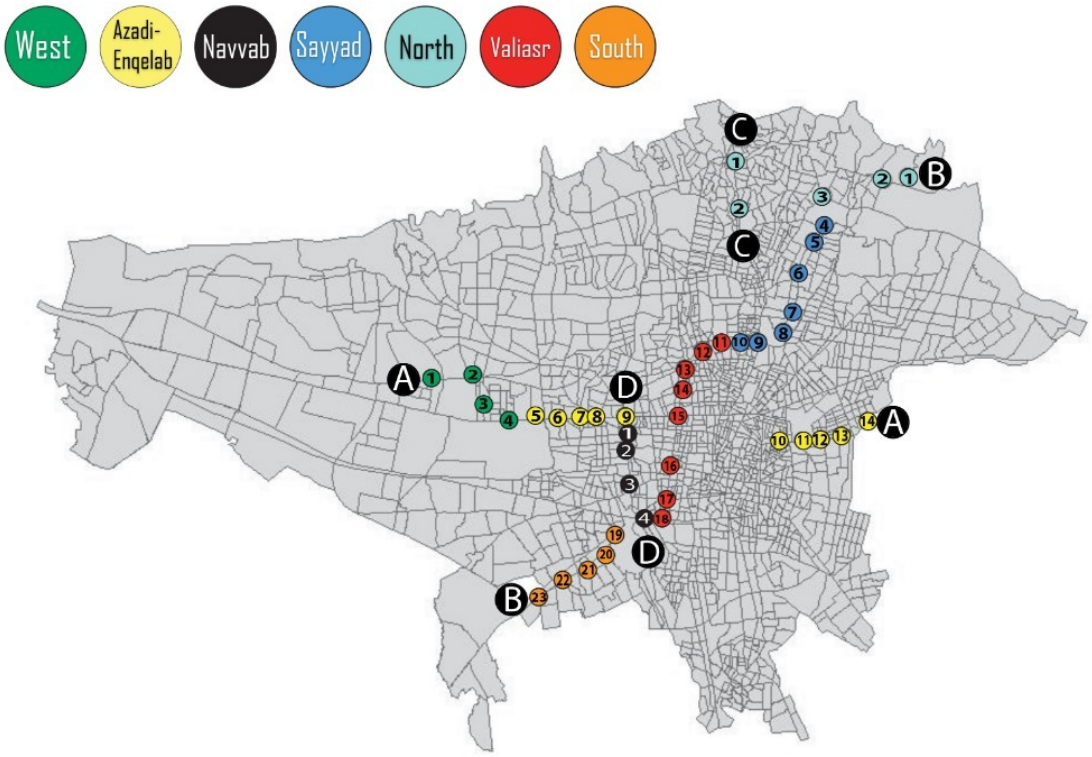

Figure 2.2: Location of intended stations of Tehran's metro rail system

Note: This map shows the location of intended stations of Tehran's metro rail system in 7 different lines showed by different colors.

the 5-digit regions during our study. The common (equivalent) geographic coordinates for all properties inside a polygon with the same first six digits of postal code is considered the geographic coordinates of the polygon center. The instruction on the conversion of the postal code to the geographical coordinates is taken from the National Post Office of the Islamic Republic of Iran. At first, we converted the postal code to the geographical coordinates, after that we have calculated distances between traded houses and metro stations. This distance represents the length of the straight line between the two points and represents the Euclidean distance. We refer to Appendix 1 for more details. In some parts of northern Tehran, the received postal code data were not accurate with the

accuracy of 6 digits, therefore 5-digit postal codes are used instead of a 6-digit postal code.

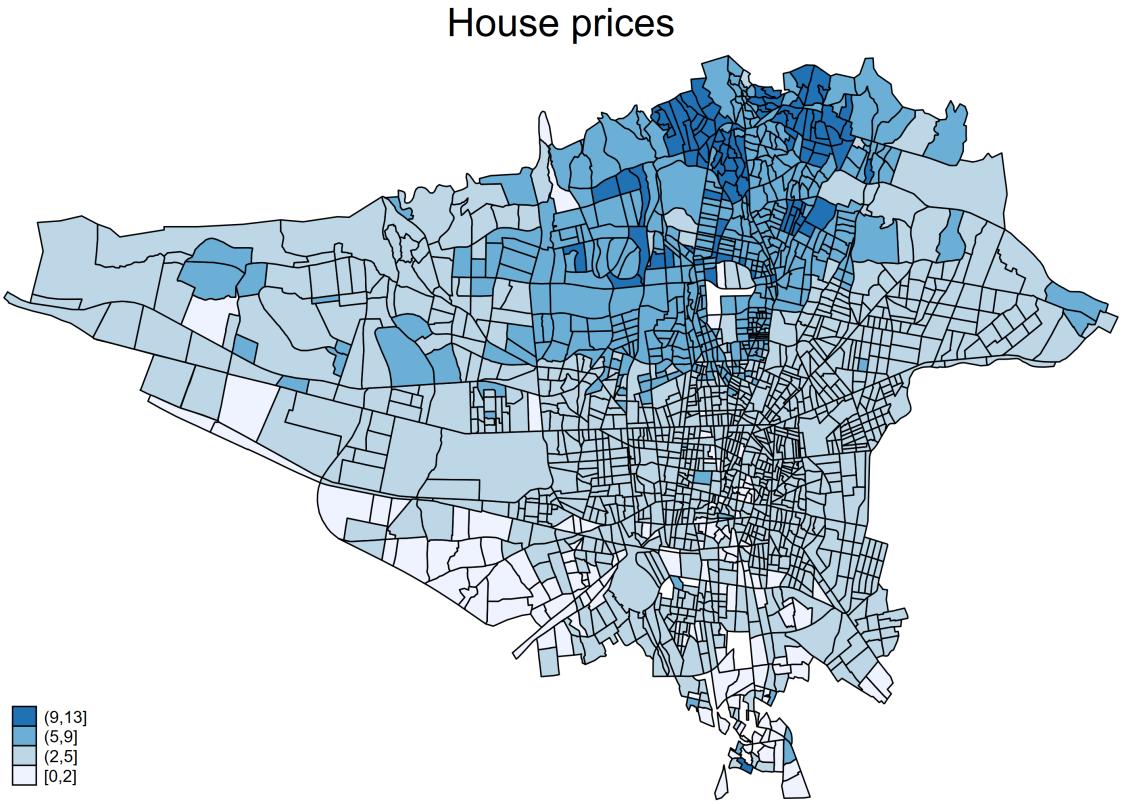

Figure 2.3: Distribution of Average Housing Price in Tehran

*Note:*This map illustrates the residential housing prices across districts in Tehran. As shown in the figure, the average housing prices in the northern districts of Tehran are significantly higher than those in the southern districts.

2.3.4 Data Limitations

There are shortcomings in the collected data that potentially may lead to a lower precision of estimates. These limitations are:

- *Postal codes:* Obtained data have only the first six digits of postal code because of the confidentiality of the information. Therefore, the exact coordinates of each house are not available. Further, in the post office databases, some of these 6-digit postal codes did not have geographical coordinates, therefore, for this group, a 5-

digit code was used instead of 6 digits, so that we can convert them to geographical coordinates.

- *Altitude:* Only latitude and longitude are involved in calculating the distance, and the information on the difference in elevation between the points is not available. This issue also causes a measurement error, because Tehran is in the Alborz mountain range, and its highest and lowest elevations are respectively 1800 meters and 900 meters above the sea level.

- *Euclidean distance:* Due to the pathways and obstacles that exist on the surface of the city, the path between the property and the metro may be a broken path, and the Euclidian distance may not be appropriate. In the other sense, the distance should be considered as the length of the shortest path between the two points based on the network of streets and roads and in general, the routes that can be traversed either ride or walk. In other words, the straight line between the two points may be very short, but the path from one to another is far longer. However, regarding the available data and information, it was not possible in this research to calculate the network distance.

- *Ahead of inauguration effects:* The opening of a metro station has various phases, including the decision to open it by the authorities, the official announcement, the start of the station construction, and finally, the official opening of the station. Here, only the official opening of the station is considered, and its effect on the price of housing is examined, while other phases may have a significant impact in this respect. Therefore, our estimate should be interpreted as a lower bound and needs to be adjusted of the effects of metro from the announcement of construction to the time of operation.

- *Prices downward bias:* Due to the tax concerns of the property owners, under re-

porting of prices is possible. The information recorded within the system is provided by real estate managers, so in some cases it is possible that the price of housing may not be reported in real value and that the price of housing may be lower due to tax evasion. Potentially, this issue can affect the results, as it is more probable that owners in the more expensive properties in the north of Tehran misreport more. However, it seems that people who live in the same area are homogeneous in this regard. It is reasonable to assume that any such bias remains constant over time. Therefore, the effect of this bias before and after metro station inauguration will be controlled for by the region fixed effect that will be introduced in the next section.

2.4 Methodology

In this section, we review the questions and hypotheses that we want to investigate, then we explain and build the identification method that would be appropriate for these hypotheses and ultimately we express the model specification and define variables.

2.4.1 Hypotheses

The main advantage of metro station is a better accessibility to public transportation. Therefore, it is expected that housing prices will grow significantly at the margins of the city with less public transportation because of the opening of the metro. In contrast, we expect not to witness a significant impact on housing prices in the city center and around streets having access to different modes of public transportation abundantly. Based on these, we define three hypotheses below:

- *Hypothesis 1:* In Tehran, the opening of a metro station, on average, causes the price of the properties around it to increase.

- *Hypothesis 2:* In Tehran, the opening of a metro station for the second time does

not have a significant effect on the price of the properties around it.

- *Hypothesis 3:* In Tehran, the opening of a metro station in different regions has a different effect on the price of the properties such that this effect is less for regions with more public transport.

2.4.2 Identification Method

As depicted in the appendix Table (2.10), the overall trend of nominal housing prices in Tehran has been increasing. It implies that after the opening of stations prices are likely to be higher than before. But apparently this increase shall not be interpreted as the causal effect of the opening of metro station. To examine our assumptions, it is necessary to have a model which can accurately identify the net impact of the metro station opening on housing prices. Difference-in-difference is the method we use to address this issue.

Difference-in-difference method is one of the main methods of identification in econometrics. In fact, in the realm of identification, we seek a causal effect of explanatory variables that is exogenous and does not have endogeneity with dependent variable. Endogeneity may arise from three sources: *i*) reverse causality; *ii*) common factors and omitted variable bias; *iii*) measurement error. To check the endogeneity, we observe that the price of housing does not affect the metro location, so there is no reverse causality problem. Inflation is one possible confounding factor that is taken care of using time fixed effects within diff-in-diff framework. Moreover, our data may have many possible measurement errors. For instance as exact location of the houses are not reported, our measure of distance to the nearest metro station is not accurate. For more information regarding omitted variables and measurement error we had a thorough discussion in 2.3.4.

To follow natural experiment, as defined in economics, we need to divide the sample (target) population into two groups of test and control. The experiment affects only the

test group, but other factors affect both test and control groups similarly. Therefore, to find the net effect of a natural experiment, it is enough to compare the difference between the outputs of these two categories. We consider houses located at a distance less than 400 meters from a metro station to be the test group and, the houses located at 400 meters to 3 kilometers from the metro station to be the control group.

2.4.3 Specification

The primary statement for each transaction i takes place in time t is as follows:

$$\ln \text{price}_{it} = \alpha + \beta_1 \text{Treat}_{it} + \beta_2 \text{Post}_{it} + \beta_3 \left(\text{Treat}_{it} \times \text{Post}_{it}\right) + \varepsilon \tag{2.1}$$

By adding other control variables, the full statement is completed as follows:

$$\begin{aligned} \ln \text{Price}_{it} =& \alpha + \beta \text{T}_{it} + \gamma \text{M}_{it} + \delta \left(\text{T}_{it} \times \text{M}_{it}\right) \\ &+ \delta_{\text{region}} + \delta_{\text{quarter}} + \theta \left(\delta_{\text{region}} \times \delta_{\text{quarter}}\right) \\ &+ \gamma_1 \text{age}_{it} + \gamma_2 \text{age}_{it}^2 + \lambda_1 \text{area}_{it} + \lambda_2 \text{area}_{it}^2 + \varepsilon_{it} \end{aligned} \tag{2.2}$$

In the above equation, δ is the difference-in-difference coefficient of interest, which indicates the effect of the opening of the metro station on its neighboring properties relative to the farther properties. Now, we introduce each of the variables used in the model.

Logarithm of price (Ln Price): The dependent variable in this statement is the logarithm of nominal price of the sold property. We use the logarithm of housing prices rather than the actual values because, as it is well known in economics, density of prices is non-negative and pretty much skewed to the right, while the density of logarithm of prices are more similar to the normal distribution. Moreover, Figure (2.4) illustrates these descriptions. Moreover, notice that we work with nominal prices throughout the paper.

Age of building (Age): The administrative OPHE data also reports the age of building

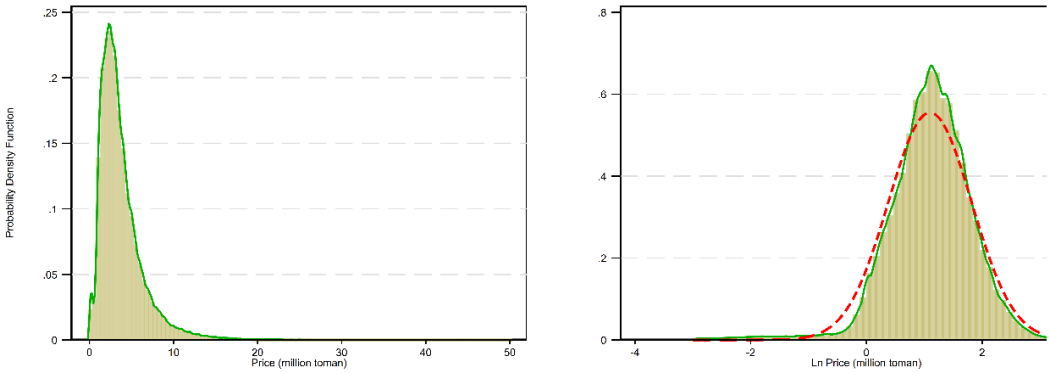

Figure 2.4: Distribution of price and ln price

for each transaction, which has been considered an effective variable on housing prices.

The area of property (Area): In addition to the age of the buildings, the area was also available in housing price data, so this variable is also considered an effective variable on housing prices. Given the importance of the two variables of age and area of building, a summary of the statistical data on the number of housing transactions based on the age and area of the building has been reported in Table (2.3).

Table 2.3: Area Distribution by Age (Years)

	Age (years)											
	0-5		*5-10*		*10-15*		*15-20*		*More than 20*		*Total*	
	Col %	Row %	Col %	Row %	Col %	Row %	Col %	Row %	Col %	Row %	Col %	Row %
Area (meters)												
0-50	7.9	29.0	12.6	22.6	17.3	27.1	15.8	15.1	7.1	6.1	11.3	100.0
50-100	60.4	39.7	66.8	21.5	66.6	18.8	68.1	11.8	53.2	8.2	62.9	100.0
100-200	29.8	51.2	19.2	16.2	15.0	11.1	15.0	6.8	36.3	14.7	24.0	100.0
200-400	1.9	45.5	1.4	16.4	1.1	11.4	1.1	6.9	3.4	19.7	1.7	100.0
More than 400	0.0	37.6	0.0	25.7	0.0	9.2	0.0	5.5	0.0	22.0	0.0	100.0
Total	100.0	41.3	100.0	20.2	100.0	17.8	100.0	10.9	100.0	9.8	100.0	100.0

Note: In each cell, the first number illustrates percentage of traded houses by age category and the second one illustrates the percentage of traded houses by surface area category. For instance, 51.2% of houses with 100-200 square meter area, are 5 or less than 5 years old and among houses younger than 5 years, only 29.8% have area between 100 and 200 square meters.

M(Treat): This dummy variable takes values 0 and 1, and it is defined to determine the distance of each traded property to the nearest metro station. If the distance between the

nearest metro station and the property is less than 400 meters, the value of this variable is set to 1, and if the distance is from 400 meters to 3 kilometers, the value of this variable is set to 0. This variable is defined for each transaction.

$$\mathrm{M}_{it} = \begin{cases} 0 & \text{Far from station } (400\text{m} - 3\text{km}) \\ 1 & \text{Near the station } (0 - 400\text{m}) \end{cases}$$

T(Post) : This variable also takes values 0 and 1, and it is defined to determine the transaction time of each traded property reference to the opening time of the nearest metro station. If the transaction time is after the opening of the nearest metro station, its value is set to 1, and if the transaction time is before the opening of the nearest metro station, it takes 0. This variable is defined associated with each transaction.

$$\mathrm{T}_{it} = \begin{cases} 0 \text{ Before openning} \\ 1 \text{ After openning} \end{cases}$$

Region: This variable is used to control location fixed effects to trace various changes that may occur in each region of the city. For each transaction, this variable takes the first three digits of the corresponding postal code. In total, Tehran is divided into 63 regions based on the first three digits of the postal codes of the properties. In other words, 62 (=63-1) dummy variables are included to the main specification, each of which is one for only one of the 3-digit postal codes and is zero otherwise.

Time: This variable is also considered to capture the fixed effects associated with the quarter of transactions. Our data span over 33 quarters. In other words, we include 32 dummy variables in our specification. Notice that inclusion of these quarter fixed effects is very important to control for the fact that house prices in Tehran have time trend and we use nominal house prices.

T*M: The coefficient of this variable, denoted by β_3, is the result of the difference-in-difference model that is the output of this research.

Time*Region: This variable also acts as a time- and region-controlling variable to capture the effects of the events occurring at different times and regions.

2.5 Results

In this section, we present the regression results. We also investigate the robustness check of treatment and control groups by testing different values in the appendix.

2.5.1 Average Effect of Metro Stations

We start by considering the distance between the property's location and the nearest metro station, setting 1 for those whose distance is less than 400 meters and 0 for those with distance more than 400m and less than 3km to the nearest metro station. In this way, we classify all transactions around the stations into two groups, the test group (with value 1) and the control group (with value 0). This case results in the value of R^2 of 75% which is highest value among different settings. In this way, as shown in Table (2.4), we find that, on average, nearby properties, after the opening of the station, face a 3.7% more growth of the price than those in farther distances[4].

It can be argued that the increase in housing prices is a combined effect of metro station inauguration and change in usage of houses around metro station. We believe this is not the case in the city of Tehran as the stations opened in the period of our analysis are located in areas that have a persistent structure in type of usage of buildings and this concern cannot significantly affect our results.

[4]The total number of housing transactions, as it said in the previous sections, was about 1,260,000 instances. However, about 427,000 properties were located at distances more than 3km from all the opened stations. Consequently, the regression sample consisted of 833,000 transactions.

Table 2.4: Regression results for average effect of metro station

	(1)	(2)	(3)	(4)	(5)
T=1	0.5941***	-0.0123***	-0.0172***	-0.0202***	-0.0248***
	(0.0015)	(0.0013)	(0.0012)	(0.0012)	(0.0015)
M=1	-0.0457***	0.0122***	0.0180***	0.0228***	0.0139***
	(0.0037)	(0.0022)	(0.0021)	(0.0021)	(0.0021)
T=1 * M=1	0.0105*	0.0236***	0.0247***	0.0226***	0.0371***
	(0.0053)	(0.0031)	(0.0030)	(0.0029)	(0.0030)
Age (centuries)			-1.1762***	-2.5029***	-2.5031***
			(0.0046)	(0.0125)	(0.0125)
Area (Hectares)			16.9128***	10.2480***	10.7196***
			(0.1210)	(0.3469)	(0.3442)
Age^2 (centuries)				4.1766***	4.1717***
				(0.0354)	(0.0352)
$Area^2$ (Hectares)				1.279×10^{2}***	1.143×10^{2}***
				(12.3798)	(12.2858)
Constant	0.8337***	-0.0478	-0.0261	0.0407	-0.0441
	(0.0012)	(0.0421)	(0.0401)	(0.0417)	(0.2509)
Region	No	Yes	Yes	Yes	Yes
Quarter	No	Yes	Yes	Yes	Yes
Frame	No	No	No	Yes	Yes
N	833,282	833,282	833,282	833,281	833,281
R-squared	.1683	.7155	.742	.7466	.7524

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Regression number (1) has no control variable and regression number (5) uses all existing control variables and fixed effects. As specified in the table, by adding control variables, the value of R^2 goes to 75.2%. The post, treat variables are defined as the time and place dummy variables.

2.5.2 Inauguration of the Metro Station for the Second Time

To test the second hypothesis, those stations that have been opened for the second time during the study are examined separately. We also estimate the primary regression without these stations. According to Table (2.5), there is no difference between the diff-in-diff coefficient (post*treat) in the two cases. The case of considering all 45 stations together and the case of removing 4 stations opened for the second time the value of this coefficient is 3.7%. Also, if we separately consider only those four stations, the coefficient is not statistically different from zero. These results indicate that those stations opened for the second time due to connection of a new line, do not have a significant impact on the prices of the properties near them. In other words, these stations have had their impact on the housing prices after their initial opening [5].

2.5.3 Clustering Stations

In this section, we divide stations based on their urban differences, and test the third hypothesis. We will explain each of these cases below.

- **North (B1-B3 and C1-C2):** Stations located in the North of Tehran are in this category. One of the characteristics of this category is that household income in these areas is higher than the average of the community and less public transport than the city center.

- **South (B19-B23):** Stations located in the south of Tehran are in this category. Regarding the weak economic conditions in the south of Tehran, it is expected that the property prices near these metro stations will improve.

- **West (A1-A4):** The common characteristic of these stations is that they are all on

[5]Notice that the diff-in-diff coefficient (Post * Treat) in the two cases (3.71% and 3.88%) are economically close, but statistically different, so we make no claim about the equivalence of columns 1 and 2 in (2.5)

Table 2.5: Regression results to test the effect of opening the station for the second time

	(1) 45 Stations	(2) 41 Stations	(3) 4 Stations
T=1	-0.0248***	-0.0233***	-0.0243***
	(0.0015)	(0.0017)	(0.0072)
M=1	0.0139***	0.0164***	-0.0178**
	(0.0021)	(0.0023)	(0.0058)
T=1 * M=1	0.0371***	0.0388***	-0.0005
	(0.0030)	(0.0032)	(0.0083)
century	-2.5031***	-2.5244***	-2.5746***
	(0.0125)	(0.0135)	(0.0314)
areaKm	1071.9687***	1381.4023***	-1755.1155***
	(34.4286)	(36.5347)	(118.1109)
century2	4.1717***	4.2409***	4.1220***
	(0.0352)	(0.0381)	(0.0908)
areaKm2	1143933.1716***	321239.9714*	9903055.8527***
	(122858.1611)	(128276.6130)	(489493.1866)
Constant	-0.0441	-0.0564	0.3082
	(0.2509)	(0.2533)	(0.1760)
N	833,281	725,519	107,762
R-squared	.7524	.7542	.7396

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

In regression number (1), all stations are considered and in regression number (2) 4 stations that have been opened for the second time have been removed. The (post * treat) factor in these two situations is roughly equal, indicating no appreciable effect on housing prices at the time of the second opening of the station.

the western margins of Tehran, and the metro is one of the most important vehicles for transportation of the residents of this region. Therefore, it is anticipated that the opening of the metro station in this region will have a positive impact on the price of housing around it.

- **Sayyad (B4-B10):** Due to the lack of a BRT line and the stations of other metro lines, it is expected that the opening of metro stations in this area will have a positive impact on the property prices around it.

- **Azadi – Enqelab (A5-A14):** Again, regarding the presence of the BRT line, which was operated before 2010, it is expected that the opening of metro stations on these streets will not have much impact on the property prices around it.

- **Vali Asr (B11-B18):** Regarding the existence of the BRT line, which was implemented before 2010, it is expected that the opening of metro stations on this street will not have much effect on the property prices around it.

- **Navvab (D1-D4):** Regarding the presence of the BRT line in this street, which was operated before 2010, it is normal that the opening of metro stations on these streets will not have much impact on the prices of the properties around it. It should be noted that these stations belong to line 7 of the Tehran Metro, which have recently been operated in 2018.

Results of the regression analysis for each of the categories are reported in Table (2.6) which indicate that the stations opened on streets with bus rapid transit (BRT) lines did not have a significant effect on the prices of the properties around it. We interpret this finding as follows: Advantage of having access to the metro station that causes the prices of the area's properties to be raised after the opening of the metro station is more and quicker access to the rest of the city. Therefore, properties with good access to BRT lines

and already easy access to city center, we find less than 2 percent effect on their prices. Categories 5, 6, and 7 have the same status.

Unlike the categories described in the previous paragraph, the properties located in Tehran's peripheral regions (north, northeast, west, and south) had a growth of prices from 2 to 11% at the time of opening of these stations. The most significant price increase is identified for the properties around the stations in the north of Tehran that includes Tajrish and Mahallati stations. These stations are in more affluent part of the city and while there is good access to well developed highways, there is relatively less public transportation in these areas, therefore the opening of the metro station in these areas cause the price of the surrounding properties to increase. The least increase is found for properties around the Sayyad highway (No.4).

Table 2.6: Regression results for 7 defined categories

	(1) North	(2) South	(3) West	(4) Sayyad	(5) Azadi	(6) Valiasr	(7) Navvab
T=1	0.0323***	0.0248*	-0.0326***	0.0105	-0.0101**	0.0753***	0.0996***
	(0.0079)	(0.0100)	(0.0059)	(0.0082)	(0.0035)	(0.0056)	(0.0129)
M=1	-0.1403***	-0.1193***	-0.0323**	-0.0819***	0.0569***	0.0516***	0.0071*
	(0.0392)	(0.0094)	(0.0101)	(0.0075)	(0.0062)	(0.0052)	(0.0029)
T * M	0.1138**	0.0688***	0.0337**	0.0010	0.0175**	0.0128	-0.0137*
	(0.0415)	(0.0133)	(0.0124)	(0.0122)	(0.0067)	(0.0088)	(0.0064)
century	-3.2597***	-2.3733***	-3.1817***	-2.7542***	-2.6335***	-2.6704***	-2.6744***
	(0.0485)	(0.0724)	(0.0397)	(0.0420)	(0.0195)	(0.0408)	(0.0364)
areaKm	2478.7349***	-152.7765	-3076.6936***	2354.8538***	1778.3606***	741.4679***	-883.3770***
	(104.4504)	(287.7454)	(135.7228)	(108.5932)	(74.4572)	(127.9021)	(166.8987)
century2	6.8146***	4.7623***	9.3918***	5.1907***	4.1099***	4.1474***	3.9768***
	(0.1437)	(0.2565)	(0.1322)	(0.1278)	(0.0532)	(0.1043)	(0.1124)
Constant	0.2933	0.6732*	0.2830	1.0138***	-1.2945***	0.0475	0.6529**
	(0.3666)	(0.3161)	(0.1889)	(0.2605)	(0.2191)	(0.2724)	(0.2147)
N	80,423	55,045	88,720	71,263	284,352	87,913	81,984
R-squared	.641	.5066	.7257	.7436	.7222	.7417	.7136

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Columns 1-4 are the categories without initial bus rapid transit (BRT) lines in these regions. On the other hand, columns number 5-7 are located near BRT lines, initially operational before metro stations are opened.

2.6 Conclusion

In this paper, using a unique administrative data of transacted housing properties in Tehran, capital of Iran, we investigate the effect of metro station inauguration on prices of proximate properties considering the proximity of other public transportation such as Bus Rapid Transit (BRT) to those Metro stations. In summary, we find that opening of the metro station in Tehran, on average, significantly has increased the price of housing in the regions around them. Studying the impact of all stations after their opening shows a 3.7% increase in property prices at a radius of 400 meters from the metro station compared with the property at a radius of 400 meters to 3 kilometers. This finding confirms earlier studies that the advantage of metro station due to ease of access to other city regions overcomes the possible disadvantages of crowding and pollution, confirming the results of Chen et al. (1998).

Using diversity of various city regions, we find that the lower the initial quality and volume of public transport near the opened metro station is, the more profound the positive effect on the price of surrounding properties will be. Our study finds the price increase of 2 to 11% of the nearby properties with less access to public modes of transportation. However, if these stations open in regions with an extensive public transportation system such as BRT lines, then there will be no significant positive impact on housing prices in those regions or even negative impact.

It is worth noting that it usually takes time for the construction of metro station from the date that the construction is publicized to the actual date of opening. Therefore, in practice, prices can adjust to the news of metro inauguration before the inauguration takes place. It implies that by comparison of prices before and after inauguration, we underestimate the effect of metro stations. Hence we interpret our findings as minimum effect of metro stations on the house prices. Nevertheless, the result of this research shows

that metro operation in Tehran generally results in at least a 3.7% increase in housing prices. Finally, further research is needed to study dynamics of house price adjustment which was beyond scope of this research.

2.7 Appendices

Calculate Distance and latitude-longitude

The geographic coordinate system is a system through which the location of each point on the earth can be determined using several components. In the coordinates, one component represents the vertical location or the height of the desired point, and the second component determines the horizontal location. An ordinary coordinate system has three components, height (elevation), latitude, and longitude. Latitude (ϕ) of each point is the northern or southern angle between the equatorial plane and the line passing through the point and the center of the earth. Points with the same latitude constitute the circuits, the circles parallel to the Equator that their radiuses vary from the largest (the Equator) to the smallest (in poles). The longitude (λ) of a point represents the eastern or western angle between the meridian on which the point is located and the prime meridian, whose longitude is zero degree. This angle is at most 180° E (East) or W (West).

The city of Tehran expands between 51°24′E and 51°36′E longitude with an approximate length of 50km and between 35°34′E and 35°50′E latitude with approximately 30km width. The geographic coordinates of each point as degrees, minutes, and seconds can be converted to the decimal degrees by the following formula:

$$\text{Decimal Degrees} \;=\; \text{Degrees} \;+ (\text{ Minutes } /60) + (\text{ Seconds } /3600)$$

For example:

$$35^\circ 40' 20'' = 35 + \frac{40}{60} + \frac{20}{3600} = 35.672222$$

To convert decimal degrees to radians it is enough to use the following formula:

$$\text{Radians} = \text{Decimal Degrees} * \frac{2\pi}{360}$$

To calculate the distance between the properties and metro stations using geographic coordinates, we should convert any geographic coordinates in decimal degrees into geographic coordinates in kilometers. The conversion of the decimal point to the kilometer varies depending on the location of that point on the globe. Let $\phi_1.\lambda_1$ and $\phi_2.\lambda_2$ be the geographical latitude and longitude in radians of two points 1 and 2, and $\Delta\sigma.\Delta\lambda$ be their absolute differences; then $\Delta\sigma$, the central angle between them, is given by the spherical law of cosines if one of the poles is used as an auxiliary third point on the sphere:

$$\Delta\sigma = \arccos\left(\sin\varphi_1 * \sin\varphi_2 + \cos\varphi_1 * \cos\varphi_2 * \cos(\Delta\lambda)\right)$$

$$d = r * \Delta\sigma \cdot r = 6371\text{km}(\text{Radius for Sphere Earth})$$

Data Cleaning

Data, received from the Ministry of Roads and Urban Development, include the total number of monthly transactions throughout the country. As mentioned before, a total of 3,900,000 transactions were conducted all over the country. Since, in this research, housing prices in Tehran must be surveyed, in the first step, only transactions of Tehran are retained that included about 1,350,000 transactions. At the next step, the data on the first six digits of the postal codes, given from the Post Office, was merged with the housing price data to eliminate traded properties whose postal codes were not in the database. About 20,000 transactions were removed at this stage because their postal codes were not accurately recorded. The remaining was arranged according to the type,

and only residential properties were considered. At this stage, about 2,000 transactions were eliminated. Reasonable intervals were considered for the parameters the price per square meter, the age of the building, and the area of the property, then the data outside that intervals were removed. The transactions in the 0.5% up and down of the data based on their price per square meter were omitted which about 15,000 transactions were in this range. For the parameter age of the building and area, properties within the 100th percentile based on their age and area were removed. In overall, after applying the restrictions and screening the data, the number of transactions left was 1,260,000 cases.

Robustness check - Treatment Group

To check robustness of the model, we change the value of the boundary from 400m to 200, 600, 800mnand 1km, and we also examine the output in these states. According to the results in the Table (2.7), by enlarging the region around the metro station, the growth rate decreases.

According to the Table (2.7), if the boundaries under experiment are reduced, the effect of the opening of the metro station on the price of the property in the corresponding region will be more apparent. More precisely, if the range considered being 200m or 400m, the effect of the opening of the metro station on the prices is 3.7%. However, if we increase the radius of the region under study to 1km, the effect of the opening of the metro station on the prices will nearly disappears. The basic case that is considered in this research is the distance one can ordinarily walk, which here are assumed 400 meters.

Robustness check - Control Group

In the Table (2.8), we also examine the range under control for other distances. In the basic case, the range under study is 3km. According to the Table 6 using the control variables of the age of the building, the building area, the location, and the date of the

transaction, if we reduce the range of controlled boundary to 2km, the effect of the opening of the metro station on the property price more significantly appears. More specifically, if the range under control is considered up to 2km, the effect of the metro opening will be 4.1%, while if we increase the range up to 6km, the impact of the metro opening will be approximately 3%. As said before, the basic case considered in this research is up to 3km.

Robustness check - Stepwise-Linear-Quadratic Model

Table (2.9) reports the results of models we consider here. In the primary mode, the distance was divided into two categories coded by 0 (400m to 3km) and 1 (up to 400m). In this case, the distance is considered as a linear and a quadratic function, and only transactions within the range of 1km of the metro station are considered, the number of transactions was 305,468 transactions. Also, a case with a stepwise function is considered. In this case, we consider distances to four categories 0 to 150m, 150 to 400m and 400m to 1km and 1 to 3km. In the case with stepwise function, the coefficient of the variable of the difference-in-difference in the first category, which includes properties in the range of up to 150 meters from the metro station, is 4.6 percent, which is smaller for the other categories, so that it is negative for the last category (400m to 1 kilometers). In the linear and quadratic case, the coefficient of the difference-in-difference variable of degree one is -4.4%, meaning that, up to 1km, for every 100 meters away from the metro station, 0.44% of the price of the property is reduced due to the opening of the metro station. The coefficient for the term of degree one is equal to -14%.

Table 2.7: Regression results in different ranges of treatment group

	(1) 200m	(2) 400m	(3) 600m	(4) 800m	(5) 1000m
T=1 * M=1	0.0484***	0.0371***	0.0271***	0.0136***	0.0111***
	(0.0062)	(0.0030)	(0.0022)	(0.0019)	(0.0019)
Age (centuries)	-2.4984***	-2.5031***	-2.5052***	-2.5119***	-2.5083***
	(0.0125)	(0.0125)	(0.0125)	(0.0125)	(0.0125)
Area (Hectar^2)	10.8345***	10.7197***	10.6780***	10.6476***	10.8049***
	(0.3444)	(0.3443)	(0.3442)	(0.3441)	(0.3441)
Age^2 (centuries)	4.1609***	4.1717***	4.1743***	4.1881***	4.1844***
	(0.0352)	(0.0352)	(0.0352)	(0.0351)	(0.0352)
Area^2 (Hectar^2)	110.7304***	114.3933***	116.0682***	116.9601***	113.1338***
	(12.2888)	(12.2858)	(12.2818)	(12.2776)	(12.2798)
Constant	-0.0388	-0.0441	-0.0575	-0.0693	-0.0659
	(0.2510)	(0.2509)	(0.2509)	(0.2508)	(0.2508)
N	833,281	833,281	833,281	833,281	833,281
R-squared	0.7522	0.7524	0.7526	0.7527	0.7526

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

As shown in the table, the post * treat coefficient is increased by shrinking the range.

Table 2.8: Regression results in different ranges of control group

	(1) 2km	(2) 3km	(3) 4km	(4) 5km	(5) 6km
T=1 * M=1	0.0413***	0.0371***	0.0349***	0.0342***	0.0307***
	(0.0030)	(0.0030)	(0.0030)	(0.0030)	(0.0030)
Age (centuries)	-2.5158***	-2.5031***	-2.4259***	-2.3996***	-2.3846***
	(0.0143)	(0.0125)	(0.0117)	(0.0112)	(0.0108)
Area (Hectares)	7.7151***	10.7196***	12.3332***	12.2424***	12.4509***
	(0.3964)	(0.3442)	(0.3236)	(0.3108)	(0.3007)
Age^2 (centuries)	4.1837***	4.1717***	4.0274***	4.0404***	4.0831***
	(0.0402)	(0.0352)	(0.0333)	(0.0321)	(0.0312)
$Area^2$ (Hectares)	$2.21 \times 10^{2***}$	$11.14 \times 10^{2***}$	$6.84 \times 10^{***}$	$9 \times 10^{***}$	$1.028 \times 10^{2***}$
	(14.2462)	(12.2858)	(11.6416)	(11.2525)	(10.9528)
Constant	-0.0341	-0.0441	-0.1212	-0.1341	-0.1510
	(0.2495)	(0.2509)	(0.2539)	(0.2534)	(0.2528)
N	628,782	833,281	977,048	1,077,506	1,169,264
R-squared	0.7538	0.7524	0.7478	0.7481	0.7478

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

As shown in the table, the post * treat coefficient is increased by shrinking the range.

Table 2.9: Comparison of linear, quadratic and stepwise models

	(1) Basic	(2) Stepwise	(3) Linear	(4) Quadratic
T=1 * M=1	0.0371***	0.0460***		
	(0.0030)	(0.0096)		
T=1 * M=2		0.0362***		
		(0.0032)		
T=1 * M=3		0.0056**		
		(0.0020)		
T=1 * M			-0.0442***	-0.1434***
			(0.0055)	(0.0276)
T=1 * M2				0.0895***
				(0.0230)
Constant	-0.0441	-0.0667	0.2523***	0.1934**
	(0.2509)	(0.2508)	(0.0679)	(0.0681)
N	833,281	833,281	305,468	305,468
R-squared	.7524	.7527	.7365	.7367

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Stepwise, linear and quadratic modes are compared with the initial state. In stepwise mode, the treatment group is divided into 3 groups of less than 150 meters, between 150 and 500 meters and 1000 meters. In linear and quadratic mode, the range is 1 km.

Table 2.10: Summary statistics of variables comparison

	2010		2011		2012		2013		2014	
	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd
Area	84.24	38.28	84.82	38.66	83.22	38.20	83.18	38.66	82.31	37.54
Price (Mill. Tomans)	1.62	.86	1.87	.89	2.57	1.25	3.73	2.03	4.01	2.20
Price (Dollars)	1480.46	785.57	1041.09	499.02	704.50	343.93	1036.44	566.40	1135.68	620.19
Age	11.41	8.19	10.97	8.51	9.59	8.32	8.05	8.31	7.19	8.19
Observations	85964		133167		168097		111369		143292	
	2015		2016		2017		2018		2019	
	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd
Area	83.56	37.59	86.04	37.07	88.22	37.35	87.67	40.48	85.94	40.09
Price (Mill. Tomans)	4.07	2.29	4.31	2.24	4.85	2.46	7.19	4.25	12.32	6.76
Price (Dollars)	1131.91	637.83	1151.65	599.18	1143.08	579.34	719.56	425.54	147.39	80.97
Age	7.15	8.17	7.74	8.40	8.57	8.81	9.22	9.07	9.64	9.01
Observations	131341		146927		162445		131727		53137	

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Chapter 3

Determinants and Consequences of Firms' Decisions Following the Russia-Ukraine War

3.1 Introduction

The Russian invasion of Ukraine in February 2022 triggered an extraordinary cascade of geopolitical, economic, and corporate responses. In reaction to the war, governments across the globe—including the United States, the United Kingdom, and the European Union—imposed sweeping sanctions on Russia. While many of these sanctions targeted the defense sector, banking, and key state-linked entities, most did not directly require foreign corporations to exit or cease operations. Yet, hundreds of multinational firms chose to voluntarily suspend or withdraw from Russia, citing reputational, ethical, and operational concerns. This wave of voluntary corporate disengagement from Russia represents a novel phenomenon in the intersection of international business, political risk, and stakeholder accountability.

This paper investigates the strategic calculus underlying these decisions. Why did some firms quickly exit the Russian market, while others chose to stay? What characteristics distinguished early movers from reluctant actors? And how did financial markets react to both the outbreak of war and firms' subsequent announcements? To answer these questions, I examine a unique dataset of over 1,200 publicly listed firms with pre-war operations in Russia, focusing on three core outcomes: (1) the likelihood of withdrawal or suspension; (2) the timing of public announcements; and (3) the stock market response to both the war and firm-level announcements.

In this context, withdrawing from Russia is important for the company from both positive and negative perspectives. First, withdrawing from Russia has a positive impact as it allows a company to preserve its public reputation and maintain its social capital. Failure to withdraw may result in the company facing global consumer backlash due to media pressure and increased public awareness. On the other hand, withdrawing from Russia could lead to increased operational risks, such as a substantial drop in company revenue due to the loss of the Russian market and the challenges in managing the supply chain. As a result, the primary research question addressed in this paper is whether preserving the reputation of the firm through withdrawal from Russia is more important than mitigating operational risk through continued operations in Russia.

Data on firms with exposure to Russia and their decisions regarding operations in the country are sourced from the database of the KSE Institute. Due to the limitations of this database—particularly its restricted coverage—this study focuses only on publicly listed firms from 17 countries. Firms are considered to have 'Russia exposure' if they had established business operations in Russia by maintaining at least one subsidiary or branch in the country prior to February 24, 2022. According to the database, 1,218 listed firms from the selected countries met this criterion. We analyze whether each of these firms chose to withdraw, suspend, or continue their operations in Russia between February 24,

2022, and June 30, 2023. Among them, 660 firms continued operations, 315 suspended their activities, and 243 fully withdrew from the Russian market.

Empirically, the analysis proceeds in three parts. First, I examine what drives the decision to exit the Russian market, analyzing country-level geopolitical factors (e.g., sanctions, trade ties), industry characteristics (e.g., public visibility), and firm-specific variables such as financial flexibility, ESG scores, and Russia-related business exposure. Second, I assess the timing of firm responses using a Cox proportional hazards model to determine which firms acted more swiftly. Third, I employ event study methods to explore how investors reacted to both the war and firms' announcements, and how these reactions varied by the timing and nature of the response.

The findings show that a firm's decision to withdraw or suspend operations was shaped by a combination of country-, industry-, and firm-level factors. Firms headquartered in countries with strong trade ties to Russia were less likely to disengage, while those from countries that imposed severe sanctions were more likely to exit. At the industry level, firms in consumer-facing sectors—where reputational pressure is higher—were more prone to act. At the firm level, those with greater liquidity, smaller size, stronger ESG social scores, and higher social visibility had a higher likelihood of withdrawing or suspending operations. These results suggest that reputational risk and institutional pressure, combined with operational flexibility, were key drivers of corporate decisions during the crisis.

The analysis of timing further reveals that firms with greater cash reserves and those in visible consumer sectors announced their decisions more quickly. In contrast, firms with stronger commercial ties to Russia or those operating in upstream industries delayed their responses, likely due to higher switching costs or strategic rigidity. While ESG and social exposure were strong predictors of exit decisions, they were not significant in determining

the speed of announcements. This indicates that reputational considerations influenced whether firms chose to act, but financial and operational constraints shaped how fast they could respond.

Finally, market reaction varied by both the timing and nature of firm responses. Firms that announced their decisions in the first or second month after the invasion faced negative stock price reactions around the announcement date, reflecting heightened uncertainty and investor concern. However, these firms often saw a recovery in the following days, suggesting that early action helped ease market pressure. In contrast, firms that delayed their announcements experienced milder or even neutral reactions, likely because investors had already priced in the expected response. Overall, the results indicate that while markets penalized firms during moments of peak uncertainty, decisive communication—especially early in the crisis—was ultimately rewarded.

This study contributes to several strands of literature. First, it adds to research on international business strategy and geopolitical risk by providing firm-level evidence on how multinational enterprises respond to war and sanctions, building on the foundational work of Henisz (2002), Kobrin (1979), Oh and Oetzel (2011), and recent insights from DeBerge (2023). Second, it contributes to the literature on ESG and reputational capital by showing that social-facing firms and those with higher ESG social scores are more likely to exit, consistent with findings in Albuquerque et al. (2020), Lins et al. (2017), and Shevchuk and Luchka (2024). Third, it informs work on financial market reactions to political shocks, showing how timing and decisiveness of firm announcements affect cumulative abnormal returns, in line with studies by Boungou and Yatié (2022), Clancey-Shang and Fu (2022), and Tosun and Eshraghi (2022). Finally, it offers a methodological contribution by introducing the "Russia Beta" proxy to measure firm-level exposure in the absence of detailed geographic revenue breakdowns, extending prior work by Lu and Huang (2022).

The paper proceeds as follows. Section 3.2 reviews the relevant literature on geopolitical risk, corporate withdrawal decisions, and capital market responses. Section 3.3 describes the data and sample construction. Section 3.4 outlines the empirical strategy. Section 3.5 presents the core findings on determinants, timing, and market responses. Section 3.6 concludes.

3.2 Literature Review

The corporate response to geopolitical crises, particularly the Russia–Ukraine conflict, has garnered significant academic attention. This literature review synthesizes recent findings on multinational enterprises' (MNEs) strategic decisions, market reactions, and the role of environmental, social, and governance (ESG) considerations. This study contributes to the intersection of international business strategy, geopolitical risk, stakeholder governance, and financial market responses to crises.

A growing body of research investigates how multinational enterprises (MNEs) respond to geopolitical risk by reevaluating their operations in politically unstable or ethically sensitive regions. The strategic decision to suspend or withdraw operations from a country under conflict is shaped by political alignment, trade dependency, and firm-specific exposure. One of the clearest recent examples is the global corporate response to the Russian invasion of Ukraine. Recent studies have examined corporate responses to the Russia–Ukraine conflict, highlighting factors influencing firms' decisions to withdraw or remain in Russia. Alam et al. (2023) analyze firm reactions to geopolitical crises, providing evidence from the Russia–Ukraine conflict. Balyuk and Fedyk (2022) investigate U.S. firms' exit decisions in response to Russia's war against Ukraine, emphasizing the role of stakeholder pressure and reputational concerns. DeBerge (2023) discusses the strategic considerations MNEs face when deciding to withdraw or remain during geopolitical crises, offering insights into the balance between home-country pressures and host-country

operations.

These findings align with earlier work on political risk in international business, which emphasizes the role of institutional context, stakeholder expectations, and firm experience in navigating crises. Foundational work by Henisz (2002), Kobrin (1979), and Oh and Oetzel (2011) examines how political risk shapes foreign direct investment and multinational decision-making. Henisz et al. (2010) expand this view by exploring how conflict and institutional uncertainty affect business environments, while Ghemawat (2001) and Li and Vashchilko (2010) stress the role of geographic and political distance in shaping international trade and investment flows. These insights are particularly relevant when firms must weigh the cost of remaining in conflict zones against reputational and operational risks of withdrawal . In particular, DeBerge (2023) highlights the reputational and strategic pressures that drive MNEs to make difficult exit decisions in politically sensitive environments.

Corporate legitimacy and stakeholder expectations have also emerged as critical factors influencing firms' geopolitical responses. Henisz and Zelner (2005) and Stevens et al. (2016) show that firm legitimacy is sensitive to both formal regulations and informal societal norms, especially when firms operate in ethically fraught environments. Pajuste and Toniolo (2022) and Hart et al. (2022) suggest that stakeholder pressures, including those from consumers, employees, and activists, can drive firms to disengage even in the absence of binding sanctions. Classic work by King and Soule (2007) and more recent insights from Clancey-Shang and Fu (2022) further underscore the role of social movements in shaping firm behavior during political conflicts.

In line with this, the role of ESG performance and reputation management has gained increasing attention. Research shows that firms with strong ESG scores tend to be more responsive to social expectations and more likely to divest from controversial markets

during crises. For instance, Albuquerque et al. (2020), Lins et al. (2017), and Demers et al. (2021) show how ESG-oriented firms were more resilient during the COVID-19 crisis, while Basnet et al. (2022), Ahmed et al. (2022), and Shevchuk and Luchka (2024) analyze how ESG considerations shaped firms' exit decisions from Russia. Dyck et al. (2019) provide international evidence that institutional investors promote stronger CSR behavior, reinforcing the idea that reputational capital constrains firm behavior during crises. In a related study, Gude and Hsiao (2024) examine how firms' social media presence and timing of corporate announcements during the Russia–Ukraine war influenced stock market responses, further supporting the role of reputational sensitivity and public visibility in shaping both firm actions and investor reactions.

Historical parallels from prior boycott and divestment campaigns also inform the current study. For example, in the anti-apartheid movement, companies in consumer-facing industries were particularly vulnerable to reputational backlash. Skinner (2017) documents how boycotts of consumer goods played a central role in the anti-apartheid movement, with firms in food and beverage sectors becoming early targets of transnational activism. Similarly, Teoh et al. (1999) demonstrate how shareholder activism influenced financial markets and corporate strategy during the South African boycott. These historical insights underscore the relevance of industry visibility and consumer-facing exposure, themes echoed in recent work on the Russia–Ukraine conflict by Tosun and Eshraghi (2022) and Servaes and Tamayo (2014).

The role of supply chain structure and trade ties also contributes to understanding firm-level exposure. Hopp and Wang (2020) highlights the strategic implications of firms' positions in global value chains. For firms operating in upstream sectors—such as raw material extraction—disentanglement from conflict zones may be more difficult and costly. Similarly, studies like Crozet et al. (2021), Huang et al. (2023), and Li et al. (2023) show that firms embedded in dense trade networks are more likely to maintain operations

in politically sensitive markets. The use of proxies such as trade volume and "Russia Beta" Lu and Huang (2022) to measure firm-level exposure adds empirical depth to this literature.

A growing body of research has examined how financial markets respond to corporate decisions during geopolitical crises, offering insights into investor sentiment, risk perception, and reputational valuation. Event studies have documented significant negative market reactions to the Russia–Ukraine war, particularly among firms with direct exposure to the region Boungou and Yatié (2022), Izzeldin et al. (2023). However, subsequent research highlights heterogeneity in these responses. Investors tended to react more favorably to firms that announced early and decisive actions—such as complete withdrawal from Russia—viewing these moves as signals of strategic clarity and risk mitigation Tosun and Eshraghi (2022), Clancey-Shang and Fu (2022), Hirshleifer et al. (2023). This builds on earlier literature showing that shareholder activism and ethical stances can materially influence firm valuation, especially when firms operate in politically sensitive environments Teoh et al. (1999), 2007social. Sectoral analyses, such as those by Boubaker et al. (2023), reveal that the financial sector experienced sharper declines, underscoring variation by industry. Additionally, Sun and Zhang (2022) provide a broad overview of global stock market reactions to the invasion, while Hirshleifer et al. (2023) demonstrate how war-related discourse influences investor expectations through media narratives. Building on this literature, the current study examines how the timing and type of firm-level announcements influence cumulative abnormal returns, providing new insights into investor perceptions of geopolitical alignment, reputational risk, and strategic exit.

3.3 Sample and Summary Statistics

To conduct a comprehensive study on the determinants and consequences of firms' decisions following the Russia-Ukraine war, five distinct data sources have been identified.

First, the KSE Institute[1] provides detailed information on firms from 17 countries with exposure to Russia prior to the onset of the war. This dataset serves as the primary data source and includes key variables such as company names, countries of origin, industries, degree of withdrawal, and official announcements regarding their actions in response to the conflict. The degree of withdrawal is categorized into three main groups: (1) Complete Exit and Withdrawal, (2) Suspension or Scaling Back, and (3) Continued Operation. The original dataset, extracted from the KSE Institute, contained approximately 1,500 observations from 21 countries as of August 2023. However, after data cleaning and filtering to retain only observations with relevant supplementary information from other datasets, the final sample consists of 1,218 firms from 17 countries. Second, global stock market return data are extracted from the Thomson Reuters Refinitiv Datastream database. Financial variables are sourced from the Worldscope database, while ESG data are obtained from ASSET4. Third, manually collected data from Twitter, Instagram, Google Trends, and news headlines provide information on firm types and public sentiment surrounding the companies and their decisions during and after the war. In addition, I constructed several discrete variables at the country, industry, and firm levels, guided by insights from the relevant literature. These variables are introduced and discussed in the following sections.

In what follows, I provide a detailed explanation of each dataset, highlighting the key variables involved. The datasets and key variables are classified into three levels: (1) Country, (2) Industry, and (3) Firm.

3.3.1 Country Level

In analyzing firms' decisions on whether to remain in, suspend operations, or withdraw from Russia in response to the Russia-Ukraine war, it is critical to account for factors operating at the country level. Due to the limited number of firms with Russian exposure

[1] Leave-russia.org

available in the KSE Institute database, the analysis focuses on 17 countries represented in the dataset, which together reflect a diverse set of economies across North America, Europe, and Asia. The primary dataset consists of 1,218 firms that had exposure to Russia prior to the onset of the war on February 24, 2022. These firms are headquartered in 17 countries, including Austria, Denmark, Finland, France, Germany, Italy, the Netherlands, Poland, Sweden, the United Kingdom, Switzerland, the United States, Canada, Japan, Australia, India, and China.

Figure (3.1) presents the distribution of firms' withdrawal decisions, as recorded in the KSE Institute database, across 17 countries. The figure shows the share of firms that have either withdrawn from, suspended operations in, or continued operations in Russia. Poland and Finland exhibit the highest exit rates, with 80

Figure (3.2) reports the average delay in the public announcement of withdrawal or suspension by firms in each country. Canadian firms reacted the fastest, with an average announcement delay of 67 days after the war began, whereas Chinese firms had the slowest response, with an average delay of 340 days.

Firms' strategic decisions in response to geopolitical shocks, such as the Russia-Ukraine war, are not made in a vacuum. Rather, they are shaped by country-specific constraints and incentives, which encompass both political and economic considerations. To capture these effects, we identify four key country-level drivers: (1) Trade dependence on Russia, (2) Geographic proximity to Russia, (3) Legal obligations arising from sanctions and regulatory frameworks, and (4) Reliance on Russian oil. In the following, I will examine each driver in detail.

- **Trade Dependence with Russia:** The degree to which a country trades with Russia—via exports or imports—plays a central role in shaping the opportunity cost of corporate withdrawal. Countries with higher economic interdependence may

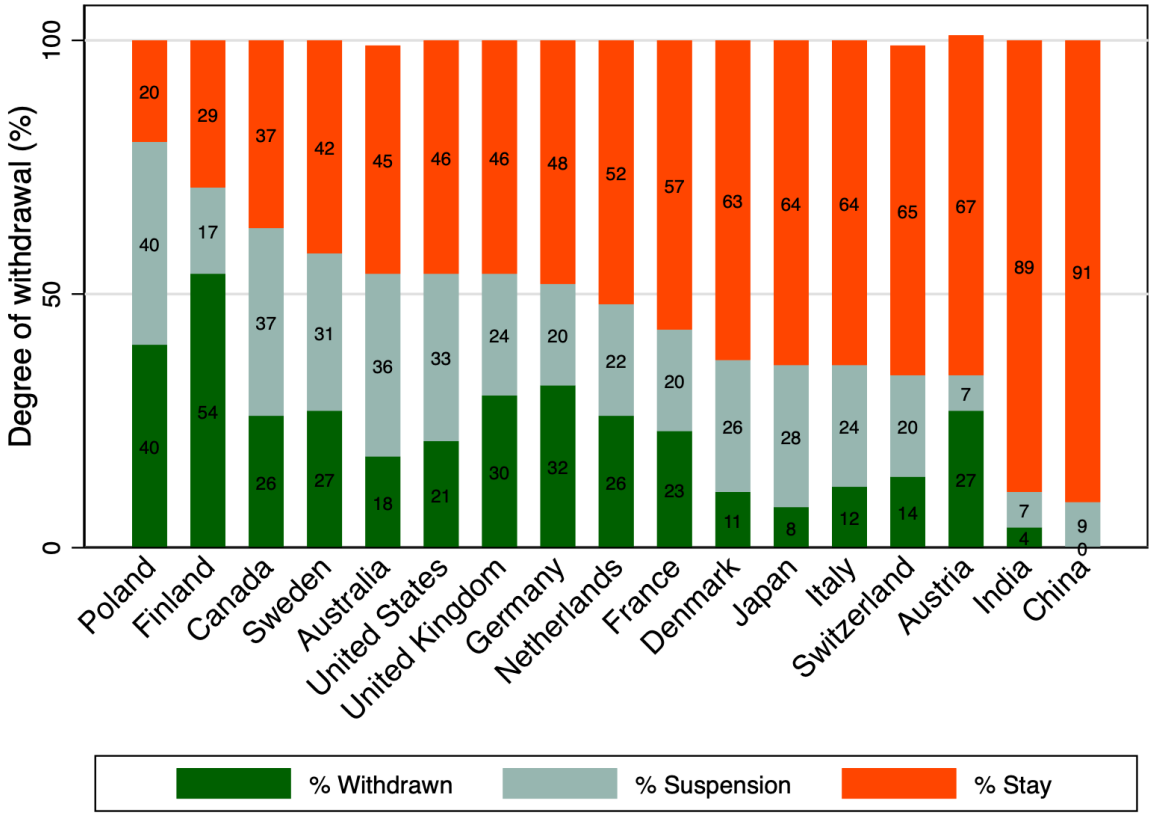

Figure 3.1: Degree of Withdrawal by Country

Note: This figure reports the share of firms that have withdrawn from, suspended operations in, or continued operating in Russia among those with prior exposure, reported by country.

face greater resistance to disengagement and stronger lobbying from local firms with significant exposure. For instance, companies headquartered in countries with deeper trade ties may be less likely to withdraw due to concerns over disrupted supply chains and lost markets Li et al. (2023). Moreover, trade volume has been shown to be a strong predictor of political and corporate behavior during geopolitical crises Borchert and Yotov (2017).

- **Geographic Proximity to Russia:** The physical distance between a firm's home country and Russia is another important factor. Proximity can influence both perceived security threats and economic spillovers. Neighboring or nearby countries

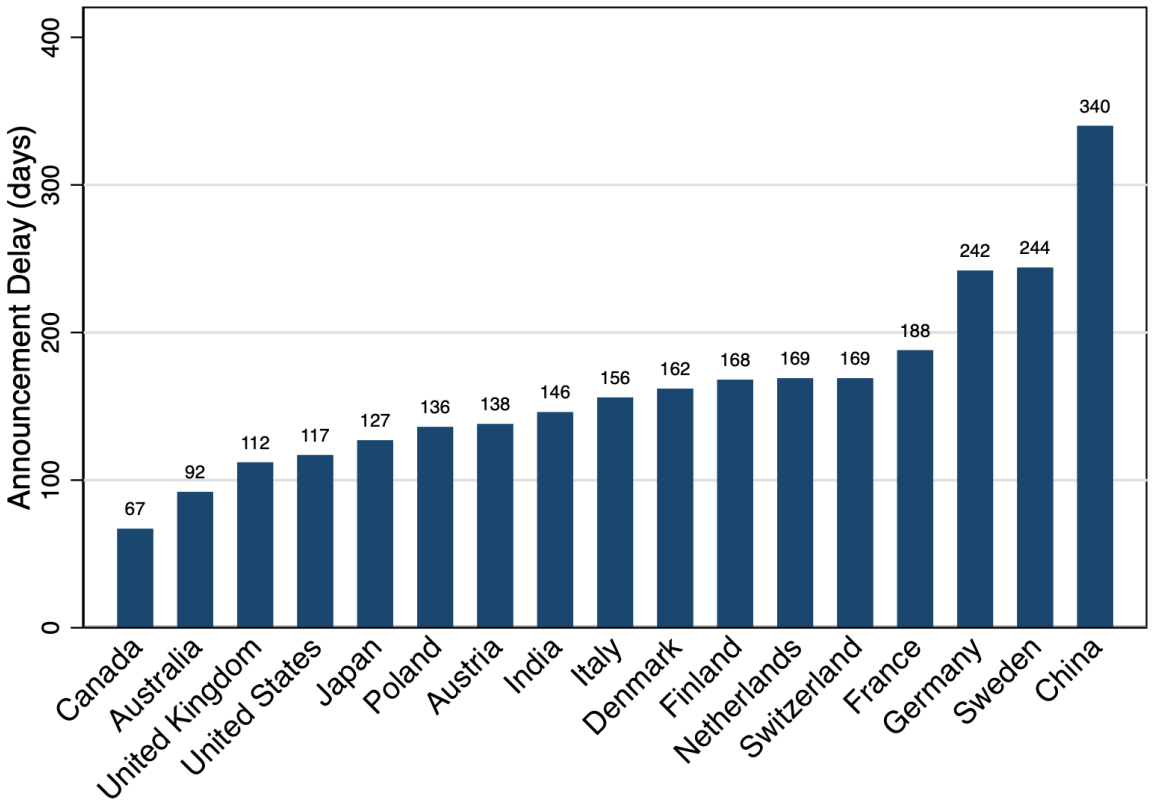

Figure 3.2: Announcement Delay by Country

Note: This figure presents the average delay, in days, between the start of the war and each firm's public announcement of withdrawal or suspension, reported by country.

may be more directly impacted by regional instability, refugee flows, or potential military escalation, creating stronger political and social pressure to disengage. Additionally, firms in nearby countries often have deeper logistical and commercial linkages with Russian operations. Research by Ossa (2015) and Head and Mayer (2014) shows that geographic distance is a persistent determinant of trade patterns and foreign investment, particularly under uncertainty and risk.

- **Legal Obligation and Sanctions:** A third factor is the legal environment, particularly the existence of binding sanctions or government directives regarding Russia. Countries differ widely in how forcefully they implemented financial sanctions, ex-

port bans, and corporate disengagement orders. For instance, firms in the U.S., UK, and EU member states were legally required to halt or limit certain business relationships with Russian entities, often under threat of penalties Evenett and Pisani (2022). These legal obligations effectively constrained corporate choice, making withdrawal less voluntary and more of a compliance issue. Prior work in international political economy shows that firms respond differently to economic sanctions depending on the strength of domestic enforcement and legal infrastructure Biersteker and Eckert (2020). The legal environment can be broken down into two subcomponents: legal obligations arising from sanctions imposed by governments and the potential influence of NATO membership. Member countries of NATO, including most European Union states, have aligned their foreign policies with the organization's defense and security agendas. Firms in NATO countries may also perceive greater security risks and economic instability from being seen as supportive of Russia or from continuing operations in Russian markets. NATO membership thus adds an element of international pressure that compounds sanctions and legal mandates, contributing to more uniform corporate responses within those nations Biersteker and Eckert (2020).

- **Oil Reliance:** Oil reliance on Russia is a crucial factor shaping firms' strategic responses to geopolitical shocks. Countries that are heavily dependent on Russian oil and energy resources face greater economic exposure, making them more vulnerable to supply disruptions and price volatility. This reliance can significantly limit the scope and intensity of sanctions governments are willing or able to impose, which in turn influences the strategic behavior of firms operating within those jurisdictions. The strategic relevance of energy dependence in shaping national and corporate responses to the Russia–Ukraine war is well documented in recent academic work Hausmann (2022); Kennedy (2022).

To operationalize the four country-level drivers introduced above, I assembled data from multiple reputable sources. First, to measure trade dependence, I used bilateral trade data between each of the 17 countries and Russia from the World Bank's World Integrated Trade Solution (WITS) Bank (2023). This dataset provides detailed annual statistics on merchandise trade—including values in USD and product counts—allowing me to calculate both countries' import and export shares involving Russia. These measures capture the degree of economic interdependence from both directions. Second, for energy reliance, I collected data from the International Energy Agency (IEA) on national oil import dependence on Russia, which reports the percentage of each country's oil imports sourced from Russia International Energy Agency (2023). Third, I quantified legal and regulatory pressure by extracting the number of sanctions imposed by each country within the first month of the Russia–Ukraine war. This includes sanctions targeting both individuals and entities, sourced from official government announcements and verified media coverage. Finally, for geographic proximity, I used capital-to-Moscow distance in kilometers, calculated using the Haversine formula based on geographic coordinates.

Table 3.1 presents summary statistics for key country-level variables across 17 countries. The average distance to Moscow is 3,924 km (SD = 3,584), reflecting varied proximity. Eight countries are NATO members. Sanctions imposed within the first month range from 0 to 568, with an average of 374. Oil dependence on Russia varies from 0% to 56.8%, with a mean of 13.3%. The % Import variable, averaging 50.84%, reflects trade dependence, ranging from 17.19% to 81.97%. % Export averages 25.29%, with values from 8.29% to 47.77%, showing moderate reliance on Russian exports. Finally, the Export to Import Ratio averages 1.72, indicating the balance of trade between countries and Russia.

At the country level, I analyze the reaction of stock markets in the 17 countries included in the study at the onset of the Russia–Ukraine war. Each country's stock market is represented by its primary stock market index, which serves as a proxy for overall market

Table 3.1: Summary Statistics—Country Level

	N	Mean	SD	Min	Median	Max
Distance (km)	17	3,923.53	3,584.09	892.00	2,374.00	14,446.00
NATO Member (1 = Yes)	17	0.47	0.51	0.00	0.00	1.00
No. of Sanctions	17	373.88	215.60	0.00	512.00	568.00
% Oil Reliance	17	13.32	15.96	0.00	6.50	56.80
% Import	17	50.84	17.62	17.19	50.77	81.97
% Export	17	25.29	11.07	8.29	25.56	47.77
Export to Import Ratio	17	1.72	1.98	0.19	0.99	6.89

Note: This table presents summary statistics of country-level variables. Distance (km) refers to the distance between each country's capital and Moscow. NATO Member is a binary indicator of membership in NATO. No. of Sanctions measures the number of sanctions imposed within the first month of the war. Oil Reliance captures the percentage of a country's oil imports coming from Russia. % Import measures the percentage of a country's total imports that came from Russia, while % Export is the percentage of a country's total exports that went to Russia. Export to Import Ratio is the ratio of exports to imports between each country and Russia.

performance. Analyzing stock market responses provides insight into how investors in different countries assessed the economic and geopolitical risks associated with the war. It also helps capture the broader financial sentiment and the extent of perceived exposure to the conflict, which can in turn influence both public opinion and corporate decision-making. In this sense, market reactions serve as an external validation of the severity of the shock across countries and offer context for understanding firms' subsequent strategic responses.

Figure (3.3) displays the return trends of these major stock indices before and after the war's commencement on February 24, 2022. The figure reveals a marked decline in stock market performance across most countries immediately following the outbreak of the conflict, reflecting the surge in geopolitical uncertainty and perceived financial risk. The impact was particularly pronounced in countries such as Austria, Poland, Finland, and Sweden, which experienced substantial drops in their stock indices. In contrast, markets in countries like China, the United States, and Canada showed more moderate declines. These observations are consistent with recent research on the global financial impact of

the war Izzeldin et al. (2023).

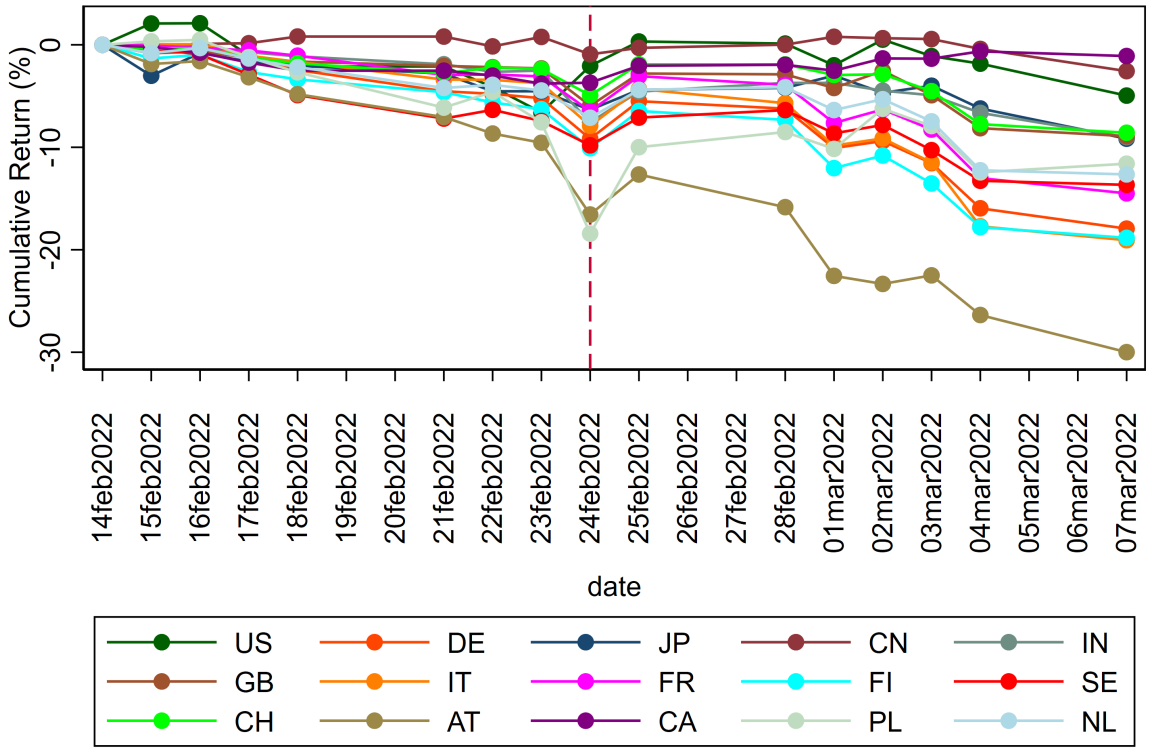

Figure 3.3: Global stock markets' reaction to the Russian invasion of Ukraine

Note: This figure illustrates the cumulative daily returns of major stock market indices in 17 countries around the time of the Russian invasion of Ukraine.

3.3.2 Industry Level

Industries play a fundamental role in shaping firm-level responses to geopolitical shocks such as the Russia–Ukraine war. While firm-specific characteristics (such as size, ownership, and political orientation) are important, a substantial body of literature in international business, political economy, and strategic management emphasizes that industry affiliation systematically influences firms' strategic decisions (Oh and Oetzel (2011); Li et al. (2023)). This is particularly relevant when companies consider whether to exit, suspend, or continue operations in a sanctioned or conflict-affected country (Tosun and Eshraghi (2022); DeBerge (2023)).

In this section, I examine the industries of firms that had operations or business ties with Russia. These firms are categorized into twelve industry groups based on the Fama-French 12 industry portfolios.

Figure (3.4) shows industry-level withdrawal behavior during the Russia–Ukraine war, revealing significant variation across sectors. The Shops and Business Equipment sectors had the highest withdrawal rates, with 55% of firms exiting Russia, indicating high sensitivity to geopolitical instability and reputational risk (Basnet et al. (2022); Clancey-Shang and Fu (2022)). In contrast, the Healthcare sector had the lowest rate at 19%, possibly due to humanitarian obligations or regulatory constraints on disengagement. This highlights differing industry risk tolerance and strategic priorities in response to geopolitical crises.

Figure (3.5) illustrates the average delay (in days) between the war's onset and firms' public withdrawal announcements. Telecom firms acted relatively quickly, with an average delay of 88 days, likely due to both public scrutiny and regulatory pressures. Conversely, Utilities firms had a longer delay of 246 days, reflecting the complex, long-term infrastructure and contractual commitments that hinder rapid exit. These variations emphasize the importance of industry-specific factors in shaping response times during geopolitical crises (Boubaker et al. (2023); Li et al. (2019)).

3.3.3 Firm Level

Within this section, I provide detailed summary statistics at the individual firm level, offering a granular perspective on the characteristics and behaviors of firms in response to the Russia–Ukraine war. The analysis is structured into five key panels, each providing distinct insights: (1) firm financial characteristics and ratios, (2) ESG scores, (3) social network metrics, (4) firm-Russia relationship, and (5) degree of withdrawal and announcement delay.

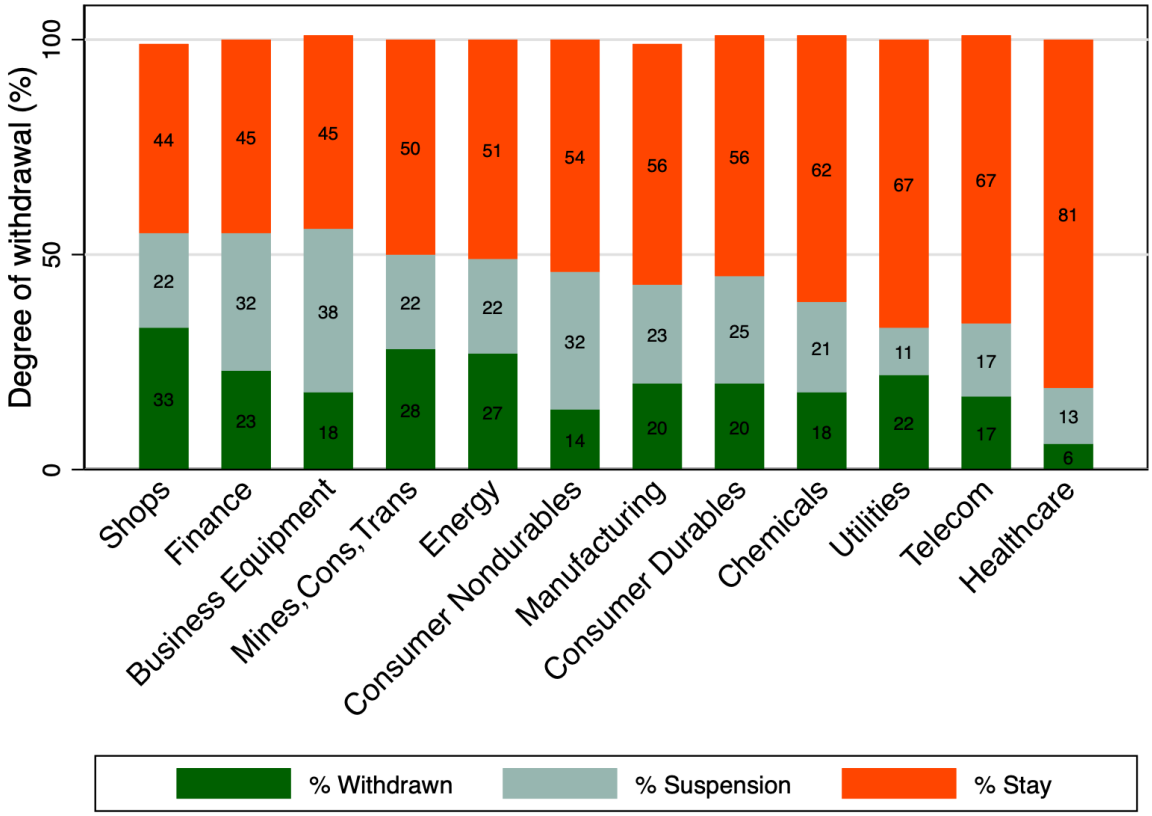

Figure 3.4: Degree of Withdrawal by Industry

Note: This figure reports the share of firms that have withdrawn from, suspended operations in, or continued operating in Russia among those with prior exposure, reported by industry.

Table (3.2) provides a comprehensive overview of firms through five panels, summarizing their financial characteristics, ESG scores, social network metrics, relationship with Russia, and degree of withdrawal. Panel A presents summary statistics of firms' key financial indicators. The average market value (Log-Market cap) of firms is 22.99 (with a standard deviation of 1.72), indicating a broad range of firm sizes. Similarly, the average total assets (Log-Asset) are 10.14, with a relatively large variation, while the average sales (Log-Sale) amount to 9.53. Profitability, measured by Return on Assets (ROA), has a mean of 0.07, but with a wide spread, indicating that many firms are not profitable, with some even reporting negative returns. Leverage (LEV) has an average of 0.62, suggesting that firms are moderately leveraged on average. The Cash Ratio, at 0.12, and Dividend

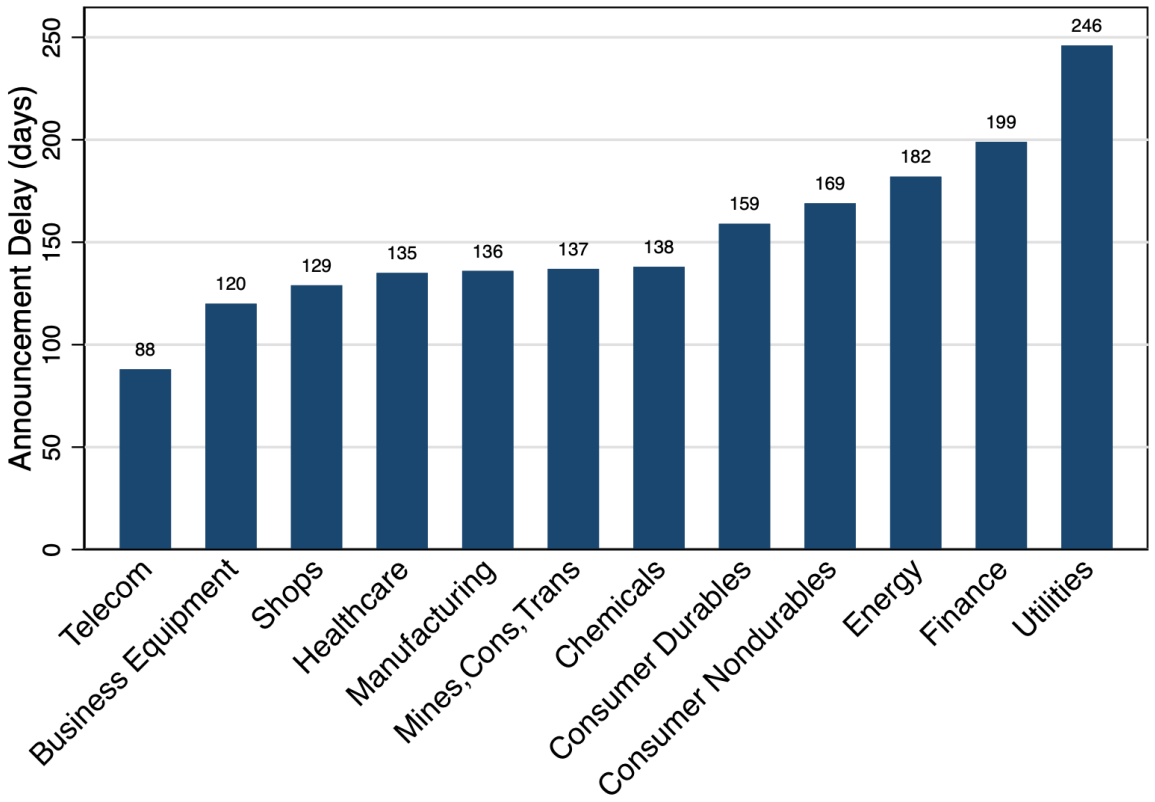

Figure 3.5: Announcement Delay by Industry

Note: This figure presents the average delay (in days) between the start of the war and each firm's public announcement of withdrawal or suspension, reported by industry.

yield, at 0.03, reflect relatively low liquidity and small dividends on average across firms.

Panel B focuses on ESG scores, with an average total ESG score of 64.59, highlighting moderate overall performance in sustainability and governance practices. The individual components of ESG show some variation: Social Score (Soc-Score) averages at 66.45, Governance Score (Gov-Score) at 65.10, and Environmental Score (Env-Score) at 60.81, indicating firms are more focused on social and governance factors compared to environmental issues.

Panel C includes "Instagram," "Twitter," and "Google search" which indicate the number of followers on the firm's Instagram and Twitter accounts, along with the Google search

index of the company name prior to the war commencement, where the average number of followers on Instagram (log Instagram) is 10.09, and on Twitter (log Twitter) is 9.49. Firms also show moderate interest in online visibility, with an average Google search index (log Google-Search) of 4.88.

Panel D illustrates the firm-Russia relationship using three variables. Russia Beta represents the coefficient from a regression of the firm's stock return on the return of the Russian stock market index, capturing the firm's exposure to market movements in Russia. The average Russia Beta is 0.30. B2C is a binary variable indicating the nature of the firm's sales in Russia: it equals 1 if the firm sells products or services to individual consumers (business-to-consumer), and 0 if it sells only to businesses (business-to-business). The binary variable B2C has a mean of 0.31, meaning that the majority of firms (69%) conduct business-to-business (B2B) transactions in Russia. The variable Upstream defines the direction of the firm's economic relationship with Russia. If Upstream = 1, the firm sources raw materials, products, or services from Russia (i.e., Russia is upstream of the firm). Conversely, if Upstream = 0, the firm sells its goods or services in Russia (i.e., the firm is upstream of Russia). The UpStream variable, with a mean of 0.37, indicates that a smaller proportion of firms source raw materials or products from Russia.

Lastly, Panel E discusses the degree of withdrawal. The table includes the number of days between the onset of the Russia-Ukraine war and firms' announcement of withdrawal, with an average delay of 147 days and a median delay of 51 days. This delay reflects the time firms took to assess the situation before publicly committing to actions regarding their operations in Russia. The wide disparity between the mean and median suggests that while some firms acted swiftly, others took considerably longer to make their decisions. In the next two tables, we examine differences across groups based on their operational status in Russia—specifically, whether firms chose to withdraw, suspend, or continue their operations. We compare all relevant variables across these groups to identify systematic

Table 3.2: Summary Statistics-Firm Level

	N	Mean	SD	Min	Max	25th	Median	75th
Panel A: Financial Characteristics								
Log-MarketCap	1,218	22.99	1.72	16.92	28.50	21.92	22.99	24.20
Log-Asset	1,218	10.14	2.57	4.95	16.64	8.27	9.83	11.71
Log-Sale	1,218	9.53	2.32	1.10	17.12	8.02	9.53	10.50
ROA	1,218	0.07	0.08	-0.94	0.54	0.03	0.07	0.10
LEV	1,218	0.62	0.23	0.00	3.52	0.48	0.62	0.75
Cash-Ratio	1,218	0.12	0.10	0.00	0.81	0.05	0.10	0.16
Dividend	1,218	0.03	0.76	-2.48	5.76	0.02	0.03	0.05
Panel B: ESG								
ESG-Score	1,218	64.59	17.42	3.44	95.76	53.92	67.64	78.09
Soc-Score	1,218	66.45	19.96	1.44	97.56	53.68	70.68	82.23
Gov-Score	1,218	65.10	19.73	8.65	97.85	52.49	68.62	80.95
Env-Score	1,218	60.81	23.33	1.23	98.90	45.57	65.23	78.78
Panel C: Social Media								
Log-Instagram	1,218	10.09	2.06	6.91	18.42	9.21	10.09	11.51
Log-Twitter	1,218	9.49	1.76	4.61	16.60	8.52	9.49	10.00
Log-Google	1,218	4.88	1.85	0.00	7.70	3.89	4.88	6.43
Panel D: Firm-Russia Relationship								
Russia-Beta	1,218	0.30	0.20	-0.35	1.05	0.16	0.28	0.41
B2C=1	378	-	-	0.00	1.00	0.00	0.00	1.00
UpStream=1	390	-	-	0.00	1.00	0.00	0.00	1.00
Panel E: Degree of Withdrawal								
Withdrawal	243	-	-	0.00	1.00	0.00	0.00	0.00
Suspension	315	-	-	0.00	1.00	0.00	0.00	1.00
Continue-Oper.	660	-	-	0.00	1.00	0.00	1.00	1.00
Announcement Delay	558	147	146	2	548	15	54	277

Note: This table provides summary statistics for the variables used in the analysis. Firm characteristics include Log-MarketCap (logarithm of market value), Log-Asset (logarithm of total assets), Log-Sale (logarithm of total sales), ROA (return on assets), LEV (leverage ratio), Cash-Ratio (cash holdings to total assets), and Dividend (dividend per share). ESG metrics include ESG-Score (composite ESG rating), Soc-Score (social score), Gov-Score (governance score), and Env-Score (environmental score). Social media variables include the logarithm of the number of firm followers on Instagram and Twitter, as well as the logarithm of the firm's Google Search Index. Firm-Russia relationship variables include Russia Beta (stock return sensitivity to the Russian market index), B2C (dummy variable equal to 1 for consumer-facing operations in Russia), and Upstream (dummy variable equal to 1 if the firm sources inputs from Russia). Degree of withdrawal includes Withdrawal (decision to fully exit), Suspension (temporary cessation), and Continue-Operation (continued activity in Russia). Announcement Delay measures the number of days between the start of the Russia–Ukraine war (February 24, 2022) and the firm's public announcement regarding its operational decision. Continuous variables are winsorized at the 1st and 99th percentiles.

differences in financial characteristics, ESG scores, social visibility, and exposure to Russia.

Table (3.3) categorizes the firms into two groups: those that have chosen to leave Russia in any degree of withdrawal and those that have decided to stay. For the purpose of classification, firms with a status of "Continue Operations" are considered as staying, while those with a status of "Scaling Back," "Suspension," or "Withdrawal" are regarded as leaving. The table provides insights into the contrasting features and attributes of firms that have opted to exit from Russia and those that have chosen to maintain their operations within the country.

The results in Table (3.3) reveal several statistically significant differences in firm characteristics and behavior. Firms that withdrew from Russia tend to be significantly larger in market value and more leveraged, while those that stayed have slightly higher sales, though this is not statistically significant. ESG-related variables are consistently higher for firms that withdrew: the ESG score, social score, governance score, and environmental score are all significantly greater, suggesting a strong alignment between ESG emphasis and exit decisions, consistent with findings in Basnet et al. (2022), Shevchuk and Luchka (2024), and Pajuste and Toniolo (2022). Similarly, firms that withdrew have significantly higher exposure to Russia, possibly reflecting greater reputational or operational risk. Moreover, these firms show greater public visibility, with significantly higher Instagram, Twitter, and Google Search indices, suggesting that more visible firms were under greater pressure to exit, as also noted by King and Soule (2007) and Ahmed et al. (2022). The UpStream indicator is also significantly different, indicating that firms with upstream operations were more likely to stay. In contrast, variables such as ROA, Dividend, and B2C are not significantly different, suggesting that profitability and business model type were less influential in the withdrawal decision.

Table (3.4) presents a comparison between firms that suspended operations and those

Table 3.3: Firm Characteristics: Staying vs. Withdrawing from Russia

	Observations		Mean		T-Stat
	Continue	Withdrawal	Continue	Withdrawal	
Log-MarketCap	660	558	22.73	23.30	-5.88
Log-Asset	660	558	10.18	10.10	0.57
Log-Sale	660	558	9.61	9.42	1.41
ROA	660	558	0.07	0.07	-1.21
LEV	660	558	0.59	0.65	-4.30
Cash-Ratio	660	558	0.12	0.13	-2.06
Dividend	660	558	0.05	-0.00	1.29
Russia-Beta	660	558	0.28	0.31	-2.78
ESG-Score	660	558	62.60	66.95	-4.37
Soc-Score	660	558	63.93	69.43	-4.84
Gov-Score	660	558	63.69	66.77	-2.72
Env-Score	660	558	59.07	62.87	-2.84
B2B	660	558	0.71	0.67	1.51
UpStream	660	558	0.45	0.27	6.96
Log-Instagram	660	558	9.64	10.63	-8.63
Log-Twitter	660	558	9.18	9.85	-6.81
Log-Google	660	558	4.57	5.25	-6.54

Note: This table compares financial variables, ESG scores, social visibility metrics, and firm–Russia relationship characteristics between firms that withdrew from Russia and those that continued operations. Columns 1 and 2 report the number of firms in each group, Columns 3 and 4 display the group means for each variable, and Column 5 shows t-statistics from two-sample t-tests. Firms are classified as "withdrawing" if they have any status of Withdrawal, Suspension, or Scaling Back, and "continuing" if they maintained operations. Continuous variables are winsorized at the 1st and 99th percentiles.

that fully withdrew. The differences here are less pronounced than in Table (3.3). Firm size and liquidity are significantly higher for suspending firms, while the UpStream variable is significantly higher among withdrawing firms, consistent with upstream-intensive firms facing more operational constraints or political sensitivities. Notably, the log Instagram score is also significantly higher for suspending firms, possibly indicating reputational awareness or efforts to manage stakeholder perceptions without a full exit. Other variables such as log Total Asset, log Sale, ROA, ESG-related scores, Russia-Beta, and Google Search do not show statistically significant differences, suggesting that among firms already engaged in Russia, the choice between suspension and full withdrawal is less correlated with financial metrics, ESG performance, or visibility than the binary decision

of staying versus leaving.

Table 3.4: Firm Characteristics: Suspension vs. Full Withdrawal from Russia

	Observations		Mean		T-Stat
	Suspension	Withdrawal	Suspension	Withdrawal	
Log-MarketCap	315	243	23.43	23.14	2.09
Log-Asset	315	243	10.25	9.91	1.62
Log-Sale	315	243	9.52	9.29	1.25
ROA	315	243	0.08	0.07	0.88
LEV	315	243	0.64	0.67	-1.76
Cash-Ratio	315	243	0.14	0.12	2.00
Dividend	315	243	-0.04	0.04	-0.75
Russia-Beta	315	243	0.31	0.32	-1.06
ESG-Score	315	243	66.06	68.10	-1.44
Soc-Score	315	243	68.29	70.91	-1.70
Gov-Score	315	243	65.83	67.98	-1.28
Env-Score	315	243	62.10	63.87	-0.90
B2B	315	243	0.66	0.69	-0.85
UpStream	315	243	0.23	0.31	-2.04
Log-Instagram	315	243	10.82	10.39	2.30
Log-Twitter	315	243	9.92	9.77	0.98
Log-Google	315	243	5.26	5.24	0.17

Note: This table compares firm characteristics between companies that suspended operations and those that fully withdrew from Russia. Columns 1 and 2 indicate the number of firms in each group, Columns 3 and 4 present group means, and Column 5 shows t-statistics. Continuous variables are winsorized at the 1st and 99th percentiles.

3.4 Empirical Strategy

This section outlines the empirical approach used to examine firms' responses to the Russia–Ukraine war, guided by three central research questions:

- What firm-, industry-, and country-level factors predict the decision to withdraw, suspend, or continue operations in Russia?
- How long does it take for firms to publicly announce these decisions?
- How do financial markets react to such announcements?

The analysis is structured around three methodologies: discrete choice models (ordered logit and multinomial logit), a survival analysis (Cox proportional hazards), and an event study of stock price reactions.

3.4.1 Theoretical Framework and Hypotheses Development

Firm responses to geopolitical shocks are shaped by a complex interplay of reputational, economic, political, and institutional factors. Drawing on literature in international business (e.g., Oh and Oetzel (2011), Li et al. (2023)), political economy (e.g., Henisz et al. (2010); Stevens et al. (2016)), and strategic management (e.g., Ghemawat (2001); Verbeke (2013)), we identify several key mechanisms that influence firms' decisions:

Reputational and stakeholder pressure: Firms with strong ESG commitments or greater social visibility are expected to be more responsive to geopolitical and ethical concerns, as reputational damage from continued operations may outweigh the economic benefits (Lins et al. (2017); Cheng et al. (2023); Hirst et al. (2023)).

Political and legal pressure: Firms headquartered in countries imposing formal sanctions may face legal obligations to suspend operations or reduce exposure, limiting discretion over strategy (Evenett and Pisani (2022); Biersteker and Eckert (2020)).

Operational flexibility and industry norms: Certain industries, such as retail and telecommunications, are more consumer-facing and reputationally sensitive, while others, like energy or utilities, may face high switching costs and complex disengagement procedures (Tosun and Eshraghi (2022); DeBerge (2023)).

Economic exposure and firm size: Larger firms or those with higher exposure to Russia may face greater economic consequences from withdrawal, influencing both the decision and timing of exit.

We also clarify that ESG scores—particularly social and governance components—serve as a proxy for firms' commitment to stakeholder-oriented behavior and reputational concerns. This is consistent with prior work on ESG and crisis response (Albuquerque et al. (2020); Basnet et al. (2022); Shevchuk and Luchka (2024)). Similarly, the firm-specific Russia Beta is used as a proxy for economic exposure to the Russian market, drawing on the logic of market betas capturing sensitivity to country-level shocks (Alam et al. (2023)).

Finally, we address the legal framework: firms headquartered in countries such as the U.S., UK, and EU were subject to formal sanctions and government mandates restricting operations in Russia, while firms from countries with weaker legal obligations faced greater strategic discretion (Beattie (2022); Lu and Huang (2022)). We explicitly incorporate these legal and institutional pressures into the empirical analysis.

3.4.2 Determinants of Withdrawal Decisions

Model Specification

We begin by modeling firms' withdrawal decisions using an ordered logit model, which is appropriate given the inherently ordered nature of the response variable: full continuation, partial suspension, and complete withdrawal. The model estimates the probability that a firm falls into one of these three categories based on observable firm-, industry-, and country-level characteristics.

The estimated model takes the following form:

$$\text{WithdrawalDegree}_i^* = \beta_0 + \beta_1 \mathbf{X}_i^{\text{financial}} + \beta_2 \mathbf{X}_i^{\text{social}} + \beta_3 \mathbf{X}_i^{\text{russia relation}} + \beta_4 \mathbf{X}_i^{\text{industry}} + \beta_5 \mathbf{X}_i^{\text{country}} + \varepsilon_i \tag{3.1}$$

where:

- $\text{WithdrawalDegree}_i^*$ is a discrete variable representing the firm's degree of withdrawal from Russia. The observed ordinal outcome Y_i is defined as:
  - $Y_i = 0$: Continued operation
  - $Y_i = 1$: Suspension or scaling back
  - $Y_i = 2$: Complete withdrawal
- $\mathbf{X}_i^{\text{financial}}$ Firm-level financial characteristics (e.g., Log-MarketCap, Log-Asset, ROA, LEV, Cash Ratio, Dividend).
- $\mathbf{X}_i^{\text{social}}$ Measures of public exposure and stakeholder orientation (e.g., ESG score and its components; social media metrics including Instagram, Twitter, and Google Search index).
- $\mathbf{X}_i^{\text{russia relation}}$ Proxies for economic ties to Russia (e.g., Russia Beta, B2C dummy, Upstream relationship).
- $\mathbf{X}_i^{\text{industry}}$ Industry-level indicators including reputational sensitivity and operational flexibility.
- $\mathbf{X}_i^{\text{country}}$ Country-level political and economic variables (e.g., number of sanctions, NATO membership, trade exposure, distance to Russia, oil reliance). [2]
- ε_i is the error term

Given the ordinal nature of the dependent variable, we employ an Ordered Logit Model.We test two alternative model specifications:

[2] All these variables are defined in the 3.3 and 3.7

1. *Baseline model*: Includes all firm-, industry-, and country-level covariates

2. *Fixed-effects model*: Replaces country and industry variables with fixed effects to absorb unobserved heterogeneity

Hypotheses

Building on the theoretical framework outlined above, we test the following hypotheses:

- **H1 (Financial capacity)**: Firms with larger market capitalization, higher leverage, and stronger liquidity positions (cash ratio) are more likely to withdraw, as they possess greater resources to absorb the cost of exit (Alfaro and Chen (2012); Alam et al. (2023)).

- **H2 (Reputational pressure)**: Firms with higher ESG scores—particularly on the social and governance dimensions—and greater social media visibility are more likely to withdraw, reflecting stakeholder pressure and reputational concerns (Lins et al. (2017); Cheng et al. (2023); Basnet et al. (2022)).

- **H3 (Economic ties to Russia)**: Firms with upstream supply chain dependence on Russia or greater Russia Beta are less likely to withdraw, due to higher economic switching costs and sunk investments (Tosun and Eshraghi (2022); Alam et al. (2023)).

- **H4 (Industry visibility)**: Firms operating in consumer-facing industries are more likely to withdraw, as their exposure to public scrutiny amplifies reputational risk (Park (2017); Li et al. (2019); Servaes and Tamayo (2014)).

- **H5 (Legal Obligation)**: Firms headquartered in countries with stronger sanctions, NATO membership, and lower trade dependence on Russia are more likely to withdraw, due to formal legal constraints and international alignment (Biersteker

and Eckert (2020); Evenett and Pisani (2022); Beattie (2022)).

3.4.3 Timing of Withdrawal: Survival Analysis

To better understand the *timing* of firms' decisions to suspend or withdraw operations from Russia following the 2022 invasion of Ukraine, we focus on the subsample of firms that eventually took such actions. The dependent variable in this analysis is *Announcement Delay*, defined as the number of days between the start of the war (February 24, 2022) and the date on which a firm publicly announced its suspension or withdrawal.

We estimate **Cox proportional hazards models** to analyze how firm-, industry-, and country-level factors influence the timing of these announcements. The Cox model is well-suited for analyzing time-to-event data and allows for right-censoring. It estimates the effect of covariates on the hazard rate—i.e., the likelihood that a firm makes an announcement at time t, conditional on not having done so yet. The model is specified as follows:

$$h(t|X_i) = h_0(t) \exp(X_i'\gamma)$$

where $h(t|X_i)$ is the hazard of firm i announcing at time t, $h_0(t)$ is the unspecified baseline hazard, and X_i is a vector of explanatory variables. These include financial characteristics (e.g., log market capitalization, leverage, ROA, cash ratio), measures of public exposure (e.g., social media following, Google search index), ESG scores, firm-specific exposure to Russia (e.g., upstream/downstream relationship, business-to-business vs consumer-facing, market beta to Russia), as well as country- and industry-level factors (e.g., sanction participation, trade exposure, industry visibility).

Firms that did not announce a withdrawal or suspension during the observation period

are treated as *right-censored*. This accounts for firms that may still consider withdrawal but had not yet made a public decision by the end of the sample window. Standard errors are clustered at the country–industry level to account for potential within-group correlation.

To complement the regression results and enhance interpretability, we also present **Kaplan–Meier failure curves**. These non-parametric plots illustrate the proportion of firms that remain operational over time and help visualize heterogeneity in withdrawal timing across key categorical variables. For clarity, we group the plots based on three sets of moderators:

1. **Country-level factors**: NATO membership and oil reliance;
2. **Firm-level characteristics**: cash ratio and firm size;
3. **Industry-level**: industry classification (consumer-facing, infrastructure, manufacturing) and nature of exit (suspension vs. withdrawal).

Hypotheses

Building on prior literature on stakeholder responsiveness, organizational flexibility, and international political risk (e.g., Oh and Oetzel (2011); Dyck et al. (2019); Henisz and Zelner (2005)), we propose the following hypotheses:

- **H6 (Organizational inertia)**: Larger firms are slower to respond due to more complex governance structures and higher operational switching costs.
- **H7 (Financial agility)**: Firms with greater liquidity (higher cash ratio) are faster to exit, as they face lower constraints in managing short-term disruptions.
- **H8 (Reputational exposure)**: Firms in consumer-facing industries or with high public visibility are more responsive to public and stakeholder pressure, leading to

quicker announcements.

- **H9 (Economic entanglement)**: Firms headquartered in countries with stronger trade ties to Russia are slower to exit due to higher economic interdependence and lobbying pressure from local interest groups (Li et al. (2023); Beattie (2022)).

3.4.4 Market Reactions: Event Study

In the final part of the empirical strategy, we investigate how financial markets responded to firms' announcements regarding their operational status in Russia. Specifically, we assess whether investors rewarded or penalized these decisions, depending on perceived reputational, operational, or geopolitical implications. This analysis draws on the broader literature on corporate social responsibility, stakeholder pressure, and financial market efficiency Lins et al. (2017); Albuquerque et al. (2020); Teoh et al. (1999).

We apply a standard *event study methodology*, using the announcement date of a firm's decision (withdrawal, suspension, or continuation) as the event date ($t = 0$). To estimate cumulative abnormal returns (CAR) using the Capital Asset Pricing Model (CAPM), we first estimate a firm-specific regression of daily returns on market returns and control variables. Specifically, Equation (3.2) models the actual return of firm i on day t as a function of its alpha (α_i), its exposure to market return ($\beta_i \cdot \text{Mkt}_{h,t}$), and firm-level controls X_i, with the error term ϵ_{it}.

$$\text{ret}_{i,t} = \alpha_i + \beta_i \cdot \text{Mkt}_{h,t} + \mu_i \cdot X_i + \epsilon_{it} \tag{3.2}$$

After estimating this model using a pre-event estimation window, the predicted or expected return $\hat{\text{ret}}_{i,t}$ is calculated using only the estimated intercept and market beta, as shown in Equation (3.3):

$$\hat{\text{ret}}_{i,t} = \hat{\alpha}_i + \hat{\beta}_i \cdot \text{Mkt}_{h,t} \tag{3.3}$$

The abnormal return (AR), defined in Equation (3.4), is computed as the difference between the actual return and the expected return under CAPM:

$$\text{AR}_{i,t} = \text{ret}_{i,t} - \hat{\text{ret}}_{i,t} \tag{3.4}$$

Finally, the cumulative abnormal return (CAR) over a specific event window from day t to day T is obtained by summing the abnormal returns across that period, as shown in Equation (3.5):

$$\text{CAR}_{i,T}^{t} = \sum_{j=t}^{T} \text{AR}_{i,j} \tag{3.5}$$

We compute average cumulative abnormal returns (CARs) across five symmetric event windows: $[-1, +1]$, $[-3, +3]$, $[-5, +5]$, $[-7, +7]$, and $[-10, +10]$. These windows capture short-term investor reactions surrounding the announcement. Statistical significance is assessed using t-tests with standard errors clustered at the firm level.

Hypotheses

- **H10**: Firms with exposure to Russia experience negative abnormal stock returns at the beginning of the Russia-Ukraine war.

- **H11**: Firms announcing a decision to withdraw or suspend operations in Russia experience positive abnormal stock returns around the announcement date.

3.4.5 Principal Component Analysis and Correlation Diagnostics

In this subsection, we examine potential correlations among selected country-level and firm-level variables and address multicollinearity concerns using Principal Component Analysis (PCA). Given that some variables reflect overlapping dimensions—such as geopolitical alignment or economic integration—incorporating them simultaneously in regression models may lead to biased or unstable estimates. To mitigate this issue while preserving the underlying information, we construct new composite indices by applying PCA to groups of highly correlated variables.

Several country-level characteristics in our analysis are conceptually and empirically related. In particular, we focus on seven variables: NATO membership, geographic distance to Russia, sanction intensity, share of imports from Russia, share of exports to Russia, export-to-import ratio, and oil reliance. These variables cluster naturally into two conceptual groups:

- **Trade-related variables** (import share, export share, export/import ratio, and oil reliance) are expected to capture overlapping dimensions of economic dependence on Russia.

- **Geopolitical variables** (NATO membership, distance, and sanctions) are similarly interrelated. NATO countries tend to be geographically closer to Russia and are more likely to have imposed strong sanctions.

We present the correlation matrix for these seven variables in Table 3.5. As expected, there are substantial correlations—especially among the trade-related and geopolitical variables—suggesting the potential for multicollinearity in regression analysis. To address this, we construct two new composite indices using PCA:

- **Legal Obligation Alignment Index (Legal)**: Combines NATO membership, distance, and sanction intensity. A higher score indicates countries that are geographically closer to Russia, are NATO members, and have imposed stronger sanctions.

- **Trade Dependence Index (Trade)**: Derived from PCA on import share, export share, export/import ratio, and oil reliance. A higher score reflects stronger economic integration with Russia through trade or energy imports.

Table 3.5: Cross-correlation Matrix

Variables	NATO	Sanctions	Distance	Reliancy	% Import	% Export	ExImRatio
NATO	1.000						
Sanctions	0.468	1.000					
	(0.058)						
Distance	-0.161	-0.485	1.000				
	(0.537)	(0.049)					
Oil Reliancy	-0.006	0.359	-0.421	1.000			
	(0.983)	(0.157)	(0.093)				
% Import	0.313	-0.013	-0.273	0.282	1.000		
	(0.222)	(0.960)	(0.290)	(0.073)			
% Export	0.438	0.049	-0.115	0.378	0.795	1.000	
	(0.079)	(0.851)	(0.660)	(0.135)	(0.000)		
ExImRatio	0.010	0.253	-0.297	0.499	0.076	0.078	1.000
	(0.970)	(0.328)	(0.247)	(0.041)	(0.091)	(0.086)	

Note: This table reports pairwise correlations between key country-level variables: NATO membership, number of sanctions imposed, distance to Moscow, oil reliance, import share, export share, and the export-to-import ratio. Corresponding p-values are shown in parentheses.

These two indices capture the core variation of the original seven country-level variables. We use them in place of the individual components in subsequent regressions to reduce dimensionality and mitigate multicollinearity, while retaining interpretability and explanatory power.

We follow a similar approach for firm-level social media exposure, measured using Twitter mentions, Instagram followers, and Google search trends. These variables are also likely

to be highly correlated, as firms with strong public visibility typically attract attention across multiple platforms. We confirm this with a correlation matrix and apply PCA to construct a single composite index:

- **Social Media Exposure Index (Social Media)**: Captures the common component of a firm's visibility across platforms. A higher value indicates greater public attention.

By replacing the individual metrics with this index, we streamline the regression specification and avoid over-representing firms with multi-platform engagement.

3.4.6 Quantify firms' exposure to Russia

To understand how involved companies are with Russia—and how the market reacts when these companies exit the country—we need to quantify their exposure to Russia. The ideal way to measure this exposure would be the share of firm revenue generated in Russia. However, for the majority of targeted firms, such segment-level data or revenue breakdowns are unavailable.

Consequently, I adopt an alternative approach by estimating each firm's beta with respect to the Russian stock market prior to the onset of the conflict. Specifically, I regress the firm's excess return on the excess return of the Russian stock market (proxied by the MOEX Index) over the period from January 2021 to December 2021. This yields a firm-level measure—hereafter referred to as the "Russia Beta"—which reflects the sensitivity of a firm's stock return to Russian market movements.

This method is inspired by the approach used in Lu and Huang (2022), who similarly construct a firm-level Russia Beta to capture latent exposure to Russian market risk when direct data on revenues or operations are unavailable.

The regression specification is as follows:

$$\mathrm{ER}_{it} = \alpha_i + \beta_i \cdot \mathrm{ER}_{\mathrm{Russia},t} + \epsilon_{it} \tag{3.6}$$

where ER_{it} denotes the excess return of firm i at time t, calculated as the firm's stock return minus the risk-free rate in its home country. $\mathrm{ER}_{\mathrm{Russia},t}$ represents the excess return on the Russian market (MOEX Index), and β_i captures the firm's exposure to Russia through its co-movement with the Russian market.

Based on Table 3.3, the average Russia Beta for firms identified as having no exposure to Russia is 0.28. For firms with some exposure to Russia, the average beta is slightly higher at 0.31. This difference, though modest, highlights a statistically significant contrast between firms with and without operational exposure to the Russian market.

3.5 Results

This section presents the empirical findings and is structured into three parts, each corresponding to a key theoretical mechanism discussed earlier: (1) firm- and stakeholder-level drivers of strategic exit (via multinomial logit regressions), (2) timing and urgency of exit decisions (via survival analysis), and (3) capital market responses to announcements (via event studies). These analyses collectively test the role of financial flexibility, reputational pressure, geopolitical exposure, and market sentiment.

3.5.1 Determinants of Withdrawal Decisions

The first part focuses on identifying the main determinants behind firms' withdrawal or stay decisions. I begin by examining firms' financial characteristics, such as profitability, leverage, and firm size, to assess whether financially stronger or weaker firms were

more likely to exit. Next, I analyze the role of social and public exposure by incorporating ESG-related measures, including environmental, social, and governance scores, along with the number of Twitter and Instagram followers and Google search index values. These variables are used to proxy for the firm's visibility and reputation. Finally, I examine the nature of each firm's relationship with Russia by introducing a "Russia beta" variable—derived from regressing firm-level stock returns on the Russian stock market index—as well as two binary indicators: whether the firm operates in a business-to-business (B2B) model and whether it operates in upstream industries. This threefold investigation helps illuminate the multidimensional factors driving corporate decisions during geopolitical crises. I also include controls for country-level and industry-level variables.

Next three tables present the results of multinomial logit regressions examining the likelihood that multinational firms continued operations in Russia (baseline), suspended activities (coded as 1), or fully withdrew (coded as 2) following the invasion of Ukraine. Each table focuses on a distinct set of predictors: financial characteristics, public/social exposure, and firm-specific ties to Russia.

Table (3.6) focuses on the role of financial characteristics in firms' decisions to leave Russia. The dependent variable captures the firm's operational status, coded as 0 for continued operation, 1 for suspension, and 2 for full withdrawal. Across all model specifications, firms with larger market capitalizations are significantly more likely to exit, suggesting that larger firms may be more sensitive to geopolitical risks or reputational concerns. Leverage is also positively and significantly associated with the likelihood of exit, implying that more indebted firms may seek to mitigate risk by exiting a volatile market. The cash ratio is another strong and economically meaningful predictor, with coefficients ranging from 1.1 to 2.2, indicating that firms with higher liquidity were more capable of suspending or terminating their Russian operations. Columns (2) and (3) sequentially add key controls: column (2) accounts for whether the firm operates in a consumer-facing

industry, and column (3) further includes country-level variables such as trade exposure to Russia and the presence of legal obligation actions. Column (4) introduces industry and country fixed effects to control for unobserved heterogeneity across sectors and countries of origin. The model's explanatory power improves with each specification, as indicated by the increase in Pseudo R^2 from 0.027 in column (1) to 0.105 in column (4), reflecting a moderate enhancement in model fit.

Table (3.7) shifts focus to social media presence and ESG characteristics. Social media engagement is a robust and significant predictor in all specifications (e.g., column 4: $\beta = 0.148$, p-value < 0.01), suggesting that firms with higher visibility or reputational exposure were more likely to exit. Similarly, higher ESG-social scores are positively correlated with exit decisions ($\beta = 0.073$, p-value < 0.1 in column 4), reflecting consistency between socially responsible signaling and corporate behavior. Environmental and governance ESG scores, however, show no significant association. As with Table (3.6), consumer-facing status, trade ties, and legal obligation exposure are gradually added in columns (2) and (3), and column (4) includes fixed effects. Model fit improves across specifications, with Pseudo R^2 rising from 0.035 to 0.113.

Column (5) extends the analysis by introducing an interaction term between social media presence and consumer-facing industry classification. The rationale is that reputational visibility may exert stronger influence on firms whose operations are directly exposed to the public, such as those in retail or consumer goods. The interaction term is positive and statistically significant ($\beta = 0.098$, p-value < 0.05), suggesting that the reputational effect of social media is amplified for firms with greater consumer exposure. In contrast, the standalone effects of social media and ESG-social score remain positive and significant, reinforcing the conclusion that reputational sensitivity was a critical factor influencing exit decisions following the Russia-Ukraine invasion.

Table 3.6: Probability of Leaving Russia - Financial Characteristics

Dependent Variable	Withdraw=2 Suspension=1 Continue=0			
	(1)	(2)	(3)	(4)
Log-MarketCap	0.228***	0.207***	0.170***	0.230***
	(0.037)	(0.037)	(0.039)	(0.052)
Log-Sale	0.072*	0.071*	0.055	0.063
	(0.033)	(0.035)	(0.037)	(0.059)
Leverage	1.114***	1.024***	0.874***	0.726**
	(0.314)	(0.312)	(0.315)	(0.350)
ROA	-0.299	-0.091	-0.579	-1.015
	(0.677)	(0.684)	(0.684)	(0.714)
Cash-Ratio	1.287**	1.101**	1.862***	2.199***
	(0.532)	(0.527)	(0.539)	(0.599)
Dividend	-0.009	0.003	-0.003	-0.009
	(0.014)	(0.013)	(0.014)	(0.017)
Consumer-Facing		0.295***	0.362***	
		(0.082)	(0.087)	
Trade			-0.010***	
			(0.003)	
Legal			0.580***	
			(0.074)	
Industry FE	No	No	No	Yes
Country FE	No	No	No	Yes
Observations	1,218	1,218	1,218	1,218
Pseudo R2	0.027	0.032	0.063	0.105

In this table, the dependent variable is a categorical variable that takes the value 2 if a firm withdraws from Russia, 1 if it suspends operations, and 0 if it continues operations. The primary independent variables include firm-specific financial measures such as Log-Market Cap (logarithm of market capitalization), Log-Sale (logarithm of total sales), Leverage (total liabilities divided by total assets), ROA (return on assets), Cash-Ratio (cash and cash equivalents to total assets), and Dividend (dividends per share). The table also includes industry and country fixed effects in model (4). Standard errors are corrected for clustering at the firm level. Robust t-statistics are reported in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Finally, Table (3.8) explores firm-specific ties to Russia. The Russia-Beta, which likely captures operational or financial sensitivity to the Russian market, is a strong and significant predictor of exit across all columns, suggesting that firms more exposed to Russia were more reactive. Conversely, firms with upstream business models (e.g., energy or com-

Table 3.7: Probability of Leaving Russia - Reputation and Social Exposure

Dependent Variable	Withdraw=2 Suspension=1 Continue=0				
	(1)	(2)	(3)	(4)	(5)
Social Media	0.156***	0.156***	0.158***	0.148***	0.135***
	(0.032)	(0.033)	(0.034)	(0.034)	(0.034)
Social Score	0.096***	0.122***	0.061*	0.073*	0.075*
	(0.034)	(0.035)	(0.036)	(0.039)	(0.039)
Environmental Score	-0.036	-0.044	-0.019	-0.007	-0.007
	(0.025)	(0.027)	(0.027)	(0.030)	(0.030)
Governance Score	0.016	0.015	-0.007	-0.012	-0.012
	(0.027)	(0.028)	(0.029)	(0.030)	(0.030)
Social Media × Consumer-Facing					0.098**
					(0.045)
Consumer-Facing		0.368***	0.373***		
		(0.083)	(0.086)		
Trade			-0.009***		
			(0.003)		
Legal			0.527***		
			(0.059)		
Control Variables	Yes	Yes	Yes	Yes	Yes
Industry FE	No	No	No	Yes	Yes
Country FE	No	No	No	Yes	Yes
Observations	1,218	1,218	1,218	1,218	1,218
Pseudo R2	0.035	0.053	0.085	0.113	0.120

In this table, the dependent variable is a categorical variable with values 2 for firm withdrawal from Russia, 1 for suspension of operations, and 0 for continued operations. The primary independent variables include Social Media (logarithm of the number of social media followers across platforms), ESG-Social Score, ESG-Environmental Score, and ESG-Governance Score. The table also includes control variables such as industry and country fixed effects in model (4). The table also includes the interaction on social media and consumer-facing as a new variable in model (5). Standard errors are corrected for clustering at the firm level. Robust t-statistics are reported in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

modities) were significantly less likely to withdraw, as indicated by consistently large and negative coefficients (e.g., column 4: β = -0.671, p-value $<$ 0.01), possibly due to higher sunk costs or more strategic importance of operations. In contrast, B2C firms show no significant association. As before, inclusion of public exposure variables and fixed effects leads to a steady increase in Pseudo R^2, reaching 0.134 in the final column.

Table 3.8: Probability of Leaving Russia - Firm-Russia Relation

Dependent Variable	Withdraw=2 Suspension=1 Continue=0			
	(1)	(2)	(3)	(4)
Russia-Beta	0.942***	0.684**	0.834***	0.638**
	(0.279)	(0.299)	(0.288)	(0.324)
B2C (=1)	0.131	0.009	-0.066	-0.050
	(0.125)	(0.137)	(0.138)	(0.145)
UpStream (=1)	-0.720***	-0.894***	-0.780***	-0.671***
	(0.131)	(0.141)	(0.142)	(0.150)
Consumer-Facing		0.355***	0.315***	
		(0.084)	(0.083)	
Trade			-0.015***	
			(0.003)	
Legal			0.988***	
			(0.148)	
Control Variables	Yes	Yes	Yes	Yes
Industry FE	No	No	No	Yes
Country FE	No	No	No	Yes
Observations	1,218	1,218	1,218	1,218
Pseudo R2	0.050	0.071	0.096	0.134

Multinomial Logit Regression of Firms' Decisions to Exit, Suspend, or Continue Operations in Russia Based on Russia Exposure and Firm Characteristics. The dependent variable takes the value 2 if a firm withdraws from Russia, 1 if it suspends operations, and 0 if it continues. The key explanatory variable is *Russia-Beta*, which captures the firm's return sensitivity to the Russian stock market. Additional firm-level indicators include whether the firm is in a business-to-consumer sector (B2C), involved in upstream production, consumer-facing, trade-intensive, or subject to legal concerns. All models control for firm-level financial variables such as size (log market cap), profitability (ROA), leverage, and cash ratio, and models (4) include industry and country fixed effects. Standard errors are corrected for clustering at the firm level. Robust t-statistics are reported in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

3.5.2 Timing of Withdrawal: Survival Analysis

The second part of the results applies a Cox proportional hazards model to study the timing of firms' public announcements. While some firms acted immediately, others delayed their decisions for weeks or months. This section aims to uncover which firm-level factors influenced the speed of response, focusing on the same three dimensions explored

earlier—financial characteristics, social exposure, and exposure to Russia—while also accounting for regional and sectoral fixed effects. The Cox model enables analysis of the time-to-event nature of the announcement and assesses the likelihood of a firm making an announcement at any given point in time.

To provide a more intuitive understanding of how different characteristics relate to announcement timing, I present Kaplan–Meier failure curves. These curves show the proportion of firms that have either suspended or withdrawn operations over time, grouped by key categorical variables. A steeper failure curve indicates faster action. I focus on three dimensions of heterogeneity: (1) country-level characteristics such as NATO membership and oil dependency; (2) firm-level financial characteristics, specifically firm size and cash holdings; and (3) industry-level factors, including industry type (infrastructure, manufacturing, consumer-facing) and the nature of the exit (suspension vs. withdrawal).

Figure (3.6) presents failure curves based on two country-level characteristics. The top panel shows three groups of firms categorized by their home country's level of reliance on Russian oil: high, medium, and low. The chart demonstrates that firms in high oil-reliant countries exited Russia more slowly, with 50% suspending or withdrawing around 160 days after the start date. In contrast, firms from low oil-reliant countries reached the 50% threshold in about 25 days, and firms from medium-reliant countries fell between these two benchmarks, indicating a gradual relationship between oil dependency and delay in exit decisions. The bottom panel separates firms by whether their home country is a member of NATO or not. Based on the figure, the first 50% of firms (in terms of announcement delay) in NATO member countries exited Russia in about 32 days, whereas it took approximately 81 days for non-member countries to reach the same level. These patterns suggest that both geopolitical alignment and energy dependency played significant roles in the timing of firms' decisions to withdraw from the Russian market. Figure (3.7) presents failure curves based on two firm-level characteristics: size and cash ratio. The top panel shows three

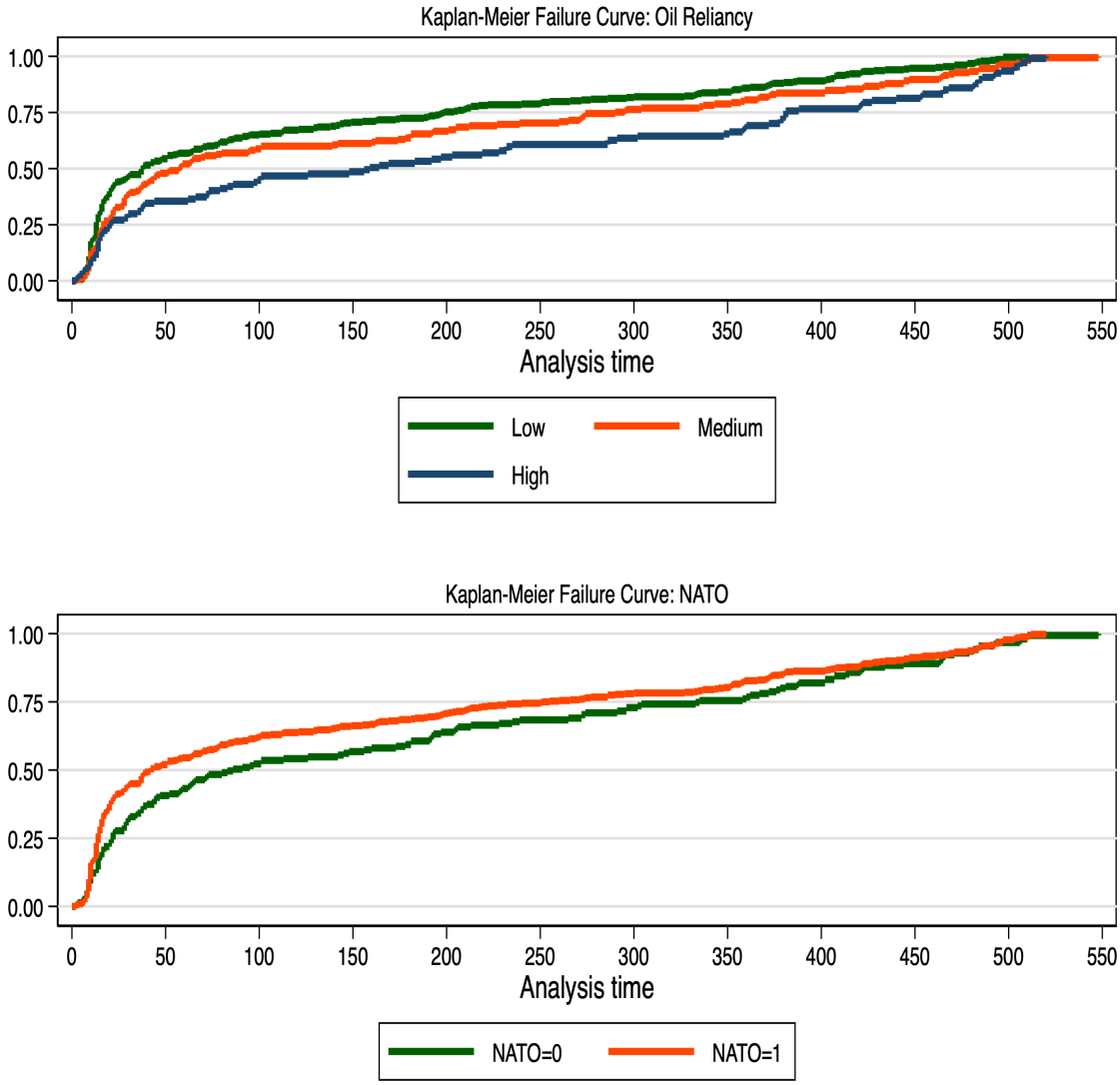

Figure 3.6: Survival Analysis - Country Factors

Note: This figure shows the timing of firm withdrawal or suspension from Russia based on country characteristics. The top panel compares firms from countries with high, medium, and low reliance on Russian oil. The bottom panel compares firms based on whether their home country is a NATO member or not.

groups of firms categorized by size: small, medium, and large. The figure reveals that smaller firms exited Russia more quickly, with 75% of small firms announcing suspension or withdrawal within 170 days. In contrast, 75% of large firms had taken action only by around 380 days, suggesting a slower response among larger firms. The bottom panel

groups firms by cash ratio (low, medium, and high). Firms with high cash holdings reacted faster, with 75% exiting within 180 days, whereas 75% of low cash ratio firms took up to 340 days to make their announcements. These results indicate that firms with greater financial flexibility were quicker to respond, while size may have introduced inertia or complexities that delayed decision-making. Figure (3.8) displays failure curves based on industry affiliation and the degree of withdrawal. The top panel groups firms into three industry categories: consumer-facing, manufacturing, and infrastructure. Firms in consumer-facing industries withdrew or suspended operations more quickly than those in infrastructure-related sectors, with manufacturing firms falling in between. This pattern may reflect higher reputational pressure and public visibility for consumer-oriented firms. The bottom panel compares firms based on the extent of their withdrawal—whether they opted for a temporary suspension or a complete exit. Firms choosing suspension acted faster, with a larger proportion announcing their decisions earlier compared to those that fully exited. This suggests that temporary suspension may have been a quicker, more flexible response during the early phase of geopolitical uncertainty.

Now, we consider all discrete and continuous variables to conduct a comprehensive survival analysis of announcement delays. Table (3.9) presents the results of a Cox proportional hazards model that estimates the impact of firm-level financial characteristics and selected control variables on the timing of announcements to suspend or withdraw operations from Russia. Only variables that were found to be significantly associated with the likelihood of exit in earlier probability models are included. The reported coefficients are hazard ratios: a value greater than 1 implies that a higher value of the corresponding variable is associated with a faster decision to exit (i.e., shorter duration), while a value less than 1 indicates a slower response (i.e., longer duration).

Across all model specifications, firm size (measured as the logarithm of market value) consistently has a hazard ratio significantly below 1, indicating that larger firms were

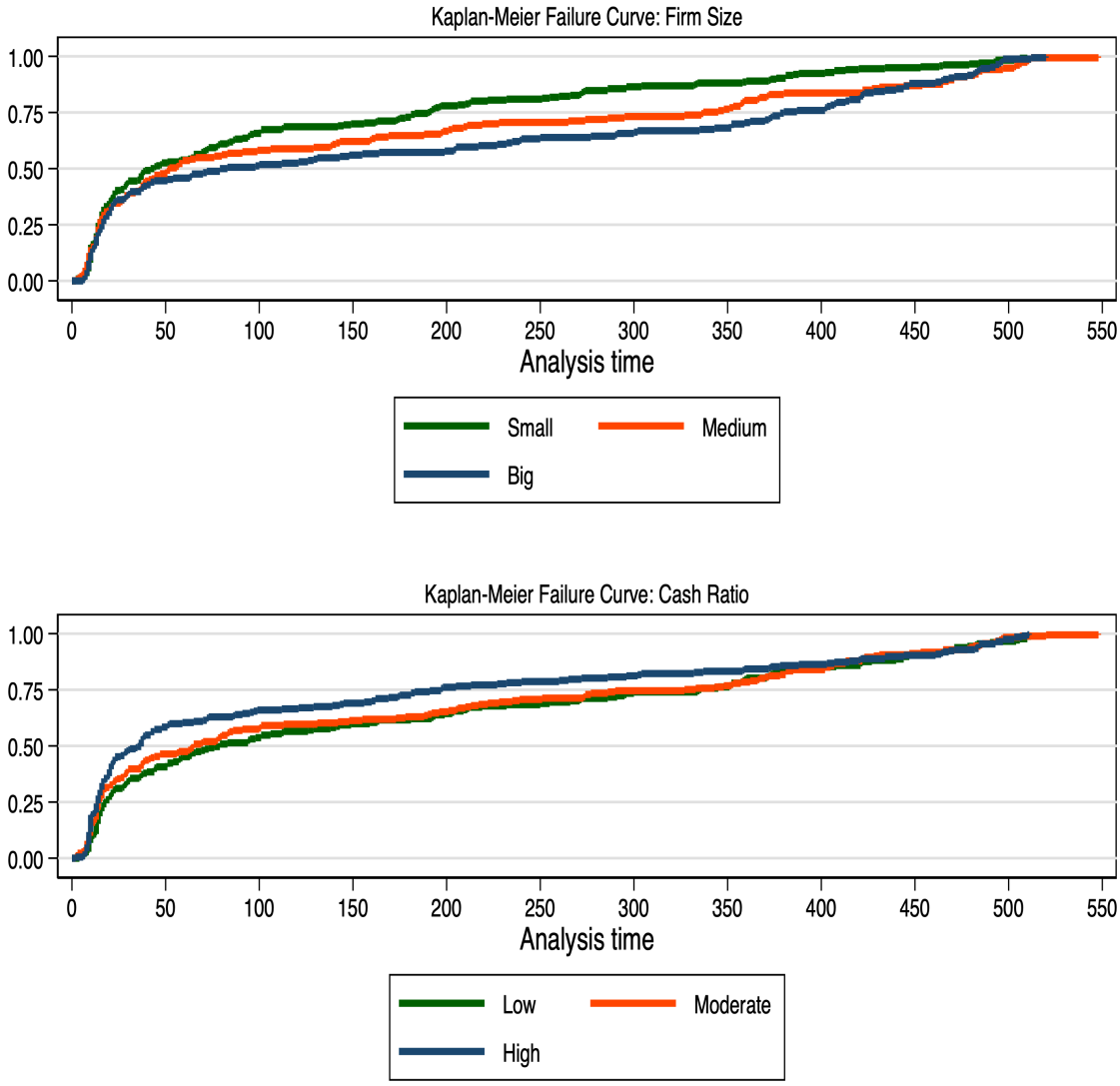

Figure 3.7: Survival Analysis - Firm Factors

Note: This figure shows the timing of firm withdrawal or suspension from Russia based on firm-level characteristics. The top panel compares firms by size (small, medium, and large) and the bottom panel compares firms by cash ratio (low, medium, and high).

slower to announce exit or suspension. This result aligns with the Kaplan-Meier curves shown earlier, which demonstrated delayed responses among large firms. The cash ratio is positively and significantly associated with the hazard of exit in the first two specifications, suggesting that more liquid firms responded more rapidly to the crisis. Leverage (LEV)

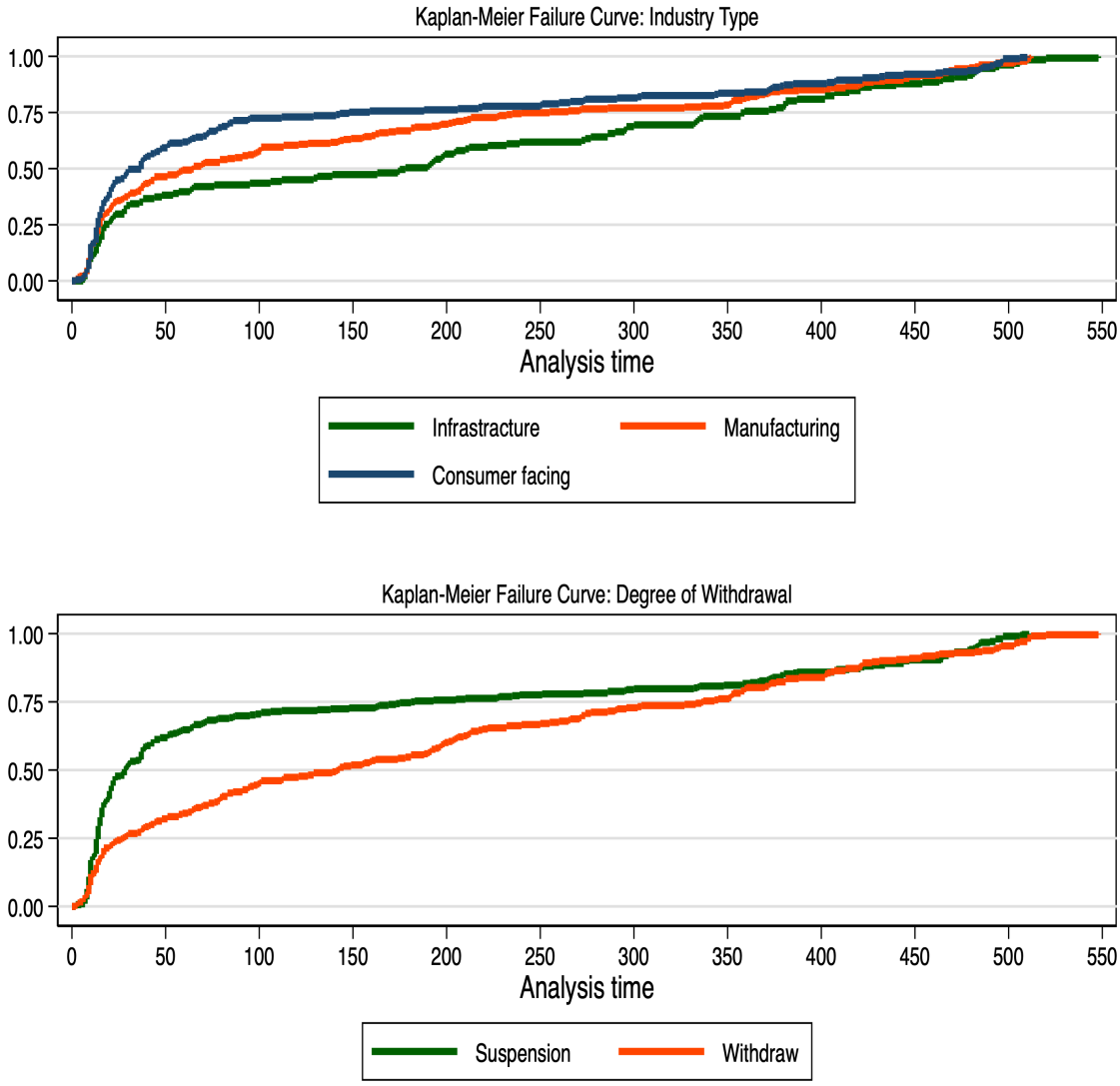

Figure 3.8: Survival Analysis - Industry and Status

Note: This figure shows the timing of firm withdrawal or suspension from Russia based on industry and the degree of withdrawal. The top panel compares firms from three industry groups: consumer-facing, manufacturing, and infrastructure. Consumer-facing firms exited more quickly than infrastructure firms. The bottom panel compares firms based on whether they ultimately suspended operations or fully exited, with suspension decisions made more quickly than complete exits.

also becomes marginally significant in some specifications, indicating that more leveraged firms may have had slightly stronger incentives to act sooner, though the result is less robust.

The industry indicator, which captures the degree to which a firm's industry is consumer-facing, is consistently and significantly greater than 1 across models, reinforcing the earlier finding that firms more exposed to consumer pressure exited more quickly. Country-level Trade remains a strong and significant predictor, with hazard ratios well below 1, indicating that firms from high-trade countries with Russia were considerably slower to act. Other control variables—such as ESG-related scores, social media exposure, Russia-specific beta, and upstream industry classification—do not show significant effects, suggesting limited influence on the timing of announcements.

3.5.3 Market Reactions: Event Study

The final part of the results evaluates how financial markets responded to key geopolitical events using an event study methodology. This analysis captures investors' reactions to two major triggers: (1) the start of the war on February 24, 2022, and (2) firm-level announcements to suspend or withdraw operations in Russia. By comparing abnormal stock returns around these events, we assess whether investors penalized or rewarded firms for their exposure to geopolitical risk and for the corporate actions they took in response.

This section contributes to understanding the capital market consequences of geopolitical shocks and strategic corporate repositioning. The findings also relate to the literature on corporate social responsibility and reputational risk, which suggests that firms can be rewarded for aligning with stakeholder expectations in crisis settings (e.g., **???**).

War Date

We begin by analyzing the market reaction on February 24, 2022—the day Russia invaded Ukraine—focusing on approximately 1,200 publicly listed firms with known exposure status to Russia. We compute abnormal returns over a symmetric 21-day window surrounding this date ([-10, +10]). Betas are estimated using the CAPM model over a 150-day

Table 3.9: Cox Proportional Hazards Model: Financial Determinants of Announcement Delay

Dependent Variable	Announcement Delay					
	(1)	(2)	(3)	(4)	(5)	(6)
Log-Market Cap	-0.088***	-0.094***	-0.125***	-0.125***	-0.105**	-0.094**
	(0.026)	(0.026)	(0.027)	(0.027)	(0.033)	(0.035)
Cash Ratio	1.157**	0.993*	0.729	0.744	0.783	0.782
	(0.401)	(0.404)	(0.401)	(0.403)	(0.415)	(0.430)
Leverage	0.281	0.428*	0.305	0.307	0.308	0.329
	(0.209)	(0.210)	(0.208)	(0.209)	(0.209)	(0.225)
Consumer-Facing		0.196***	0.174**	0.179**	0.177**	
		(0.059)	(0.059)	(0.060)	(0.060)	
Trade			-0.281***	-0.292***	-0.282***	
			(0.060)	(0.062)	(0.063)	
Sanction			-0.026	-0.028	-0.025	-0.020
			(0.052)	(0.052)	(0.052)	(0.053)
Russia-Beta				0.161	0.156	0.162
				(0.237)	(0.237)	(0.248)
Upstream (=1)				0.012	0.013	0.017
				(0.100)	(0.101)	(0.109)
Social Media					-0.026	-0.032
					(0.034)	(0.036)
ESG- Social Score					-0.017	-0.023
					(0.024)	(0.025)
Industry FE	No	No	No	No	No	Yes
Country FE	No	No	No	No	No	Yes
Observations	558	558	558	558	558	558

This table presents the results of Cox proportional hazards regressions examining the effect of firm-level financial characteristics and selected control variables on the timing of firms' announcements to suspend or withdraw operations from Russia. The dependent variable is the number of days from the start of the conflict until the firm's public announcement. Hazard ratios are reported, with standard errors shown in parentheses. A hazard ratio greater than 1 indicates a shorter time to announcement (i.e., faster response), while a ratio less than 1 suggests a longer delay. Only variables that were previously found to significantly predict the probability of withdrawal are included in the analysis. Standard errors are corrected for clustering at the firm level. Robust t-statistics are reported in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

estimation window ending in January 2022. This allows us to construct firm-specific expected returns, against which actual returns are compared to calculate abnormal returns.

Figure 3.9 shows the CARs around the war date across three panels. Panel A displays CARs for firms without Russian exposure, Panel B for those with exposure, and Panel C presents the difference. Firms exposed to Russia began underperforming even before February 24, likely reflecting rising tensions as troops amassed at the border. The divergence accelerates post-invasion: exposed firms experienced a sharp decline in CARs, in contrast to the relatively flat performance of unexposed firms.

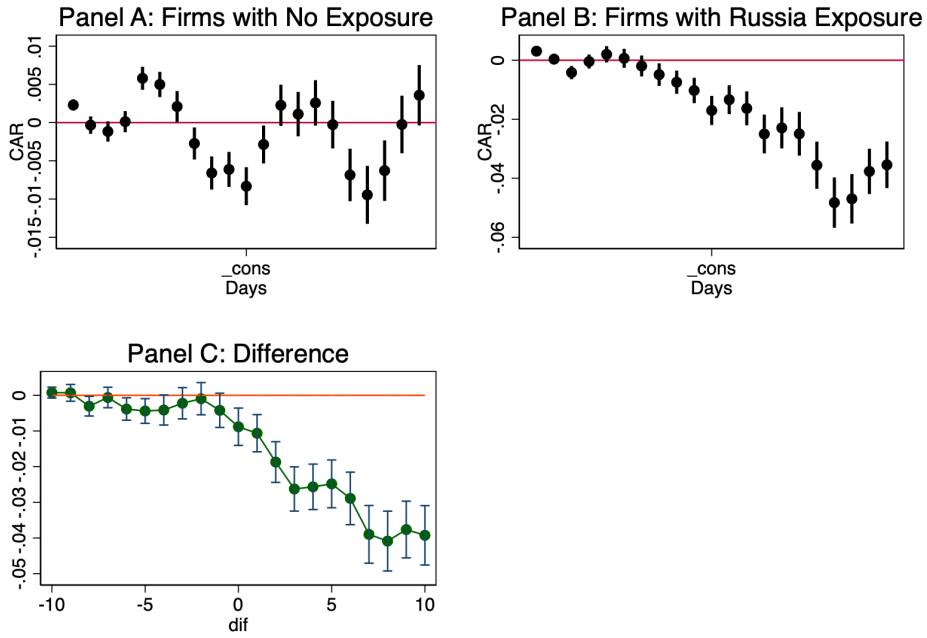

Figure 3.9: War Date- Russia Exposure vs. No Exposure

Note: These figures show the Cumulative Abnormal Returns (CAR) for firms over a 10-day period around the war announcement date, divided into three panels. Panel A depicts CAR for firms without Russia exposure. In Panel B, CAR is shown for firms with Russia exposure. Panel C highlights the difference between these two CARs. A clear observation is that CAR for firms with Russia exposure sharply drops after the war announcement, in contrast to firms with no exposure.

In Figure 3.10, we re-segment firms based on post-war decisions. Panel A shows CARs for firms that stayed in Russia; Panel B for firms that exited; and Panel C plots their difference. Firms that later exited Russia experienced steeper negative returns even before February 24 and a more substantial decline afterward. This suggests that exit decisions were endogenous, driven by market pressure and risk considerations. The divergence in

CARs indicates investor expectations of reputational or operational damage associated with Russian exposure.

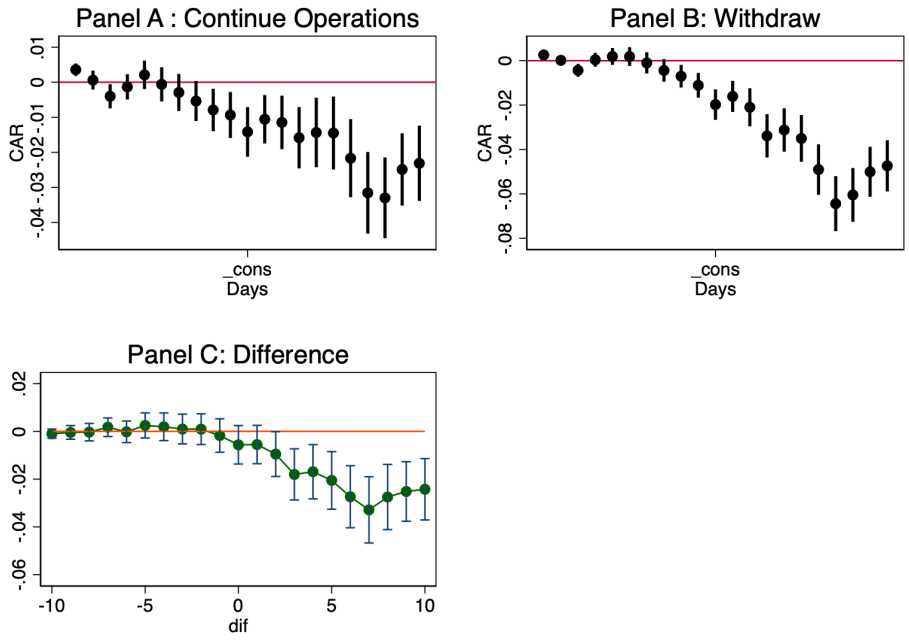

Figure 3.10: War Date- Remained Firms vs. Exited Firms

Note: These figures display Cumulative Abnormal Returns (CAR) for firms over a 10-day period centered on the war commencement date. It consists of three panels: Panel A shows CAR for firms continuing operations in Russia after the war, Panel B depicts CAR for firms withdrawing from Russia post-war, and Panel C highlights the difference between these two CARs. Notably, the negative CAR, reflecting shareholder pressure, distinctly affects firms' choices to exit Russia.

Announcement Date

Next, we examine how markets reacted to firms' announcements to suspend or withdraw operations. This analysis focuses on firms that made such announcements post-invasion. Using the same event study specification as before, we compute abnormal returns around the firm-specific announcement date.

Figure 3.11 displays the average cumulative abnormal returns (CARs) over a 21-day event window (from 10 days before to 10 days after the announcement date, denoted as Day 0), segmented by the timing of firms' announcements. The timing is grouped

into four categories based on how soon the announcement occurred following the onset of the war (February 24, 2022). Panel A includes firms that announced their withdrawal or suspension within the first month after the war began. Panel B shows firms that made announcements during the second month. Panel C covers announcements made in the third month, and Panel D includes firms that disclosed their decisions more than three months after the start of the war.

The stock market reaction depends on how soon the firm made its announcement. In Panels A and B, firms that acted in the first or second month saw a sharp drop in returns before their announcement—likely because investors expected negative impacts from staying in Russia. After announcing, these firms' stock prices began to recover, suggesting the market viewed withdrawal or suspension as a positive step. In Panel C, firms announcing in the third month saw smaller price drops before their announcement and a weaker recovery after, showing that the market's response was more neutral at that stage. Finally, in Panel D, firms that waited more than three months saw no clear pattern before the announcement and a slight improvement afterward. Overall, these results suggest that announcing early helped reduce market pressure, while delayed responses had less impact—possibly because the news was no longer surprising. Investors seemed to reward quick and decisive action during the early stages of the crisis.

Additionally, Table 3.10 reports the average cumulative abnormal returns (CARs) surrounding firm announcements of withdrawal or suspension from Russia, segmented by the timing of the announcement relative to the start of the war. The announcements are grouped into four categories: those made within the first month, the second month, the third month, and beyond three months. CARs are computed across a series of symmetric event windows centered on the announcement day, ranging from the event day itself (Day 0) to a broader 21-day window ($[-10, +10]$). For each window and group, the table reports the average CAR and the corresponding standard errors in parentheses.

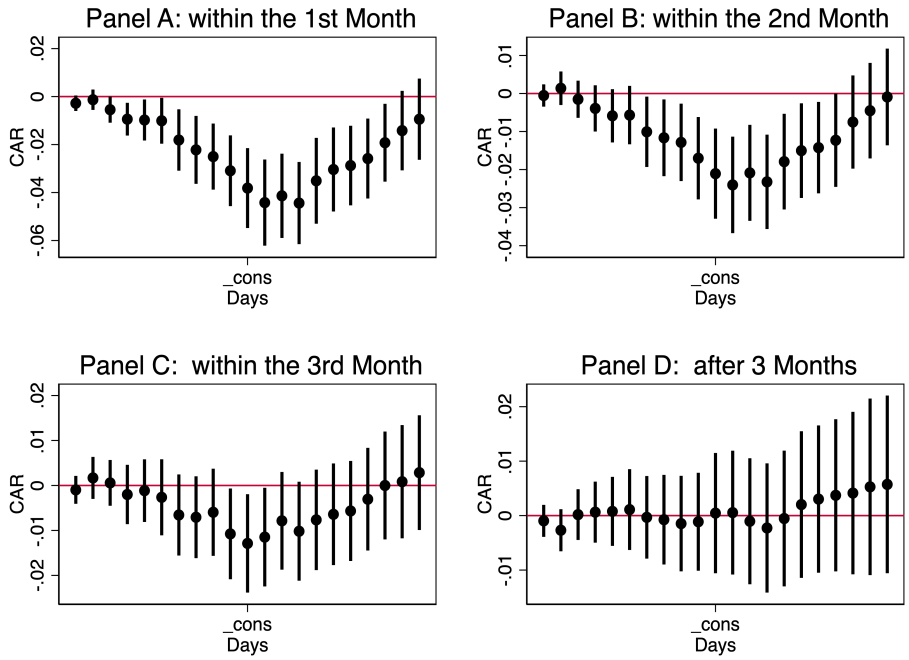

Figure 3.11: Action Announcement Date

Note: This figure presents average cumulative abnormal returns (CARs) from 10 days before to 10 days after the firm's announcement to suspend or withdraw from Russia, segmented by the timing of the announcement.

The results show that market reactions were more negative when firms announced their decisions shortly after the war began. For example, firms that announced withdrawal or suspension within the first month experienced a CAR of -1.1% on the event day, with the decline reaching -5.5% over the $[-10, +10]$ window. Similar patterns are observed for announcements made in the second and third months, though the magnitude of negative reactions diminishes over time. In contrast, announcements made more than three months after the invasion show no significant negative market response and even exhibit mildly positive CARs over longer windows. These patterns suggest that early announcements were interpreted as reactive to severe geopolitical risks, while later announcements may have been viewed as more deliberate and less disruptive to firm value. This time-dependent effect highlights how investor sentiment evolved as the war—and firms' responses—unfolded.

Table 3.10: Cumulative Abnormal Returns (CAR) by Timing of Announcement

Event Window	1st Month	2nd Month	3rd Month	After 3 Months
Day 0	-0.011***	-0.008***	-0.004	0.002
	(0.002)	(0.002)	(0.003)	(0.003)
$[-1, +1]$	-0.020***	-0.015***	-0.006	0.003
	(0.004)	(0.004)	(0.005)	(0.005)
$[-3, +3]$	-0.035***	-0.025***	-0.010	0.005
	(0.006)	(0.006)	(0.007)	(0.008)
$[-5, +5]$	-0.045***	-0.030**	-0.012	0.007
	(0.008)	(0.008)	(0.009)	(0.010)
$[-7, +7]$	-0.050***	-0.032**	-0.013	0.010
	(0.009)	(0.009)	(0.010)	(0.011)
$[-10, +10]$	-0.055***	-0.035**	-0.015	0.013
	(0.010)	(0.010)	(0.012)	(0.013)
Observations	153	121	98	186

Notes: This table shows the average cumulative abnormal returns (CAR) around the firm's withdrawal or suspension announcement, grouped by when the announcement occurred relative to the war start. Standard errors are in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

3.6 Conclusion

This paper investigates how multinational firms responded to the Russia–Ukraine war by analyzing the determinants, timing, and market reactions of their withdrawal or suspension decisions. Using a novel dataset that integrates firm financials, ESG scores, social visibility metrics, geopolitical variables, and stock market data, the analysis provides new insights into the strategic logic behind corporate disengagement in response to geopolitical crises.

The findings highlight that firm exit decisions were driven by both structural and reputational factors. Firms from countries imposing stricter sanctions were more likely to disengage, while those from countries with deeper trade ties to Russia were more reluctant.

At the firm level, greater liquidity, smaller size, higher ESG social scores, and broader public visibility significantly increased the likelihood of withdrawal. These patterns underscore that withdrawal was not only a matter of economic calculus but also a function of reputational exposure and stakeholder pressure. Timing analysis further shows that firms with greater financial flexibility and consumer-facing operations acted more quickly, whereas larger and more deeply embedded firms delayed action—especially those from countries with high trade dependency on Russia.

Stock market reactions were strongly time-dependent. Firms announcing exits early in the war faced negative market responses around the announcement date, reflecting high investor uncertainty. However, these firms often experienced a recovery in subsequent days, suggesting that decisive action helped ease reputational and operational concerns. In contrast, firms announcing later encountered more neutral or even positive market responses, likely because their actions were anticipated and less disruptive. These patterns suggest that financial markets valued transparency and responsiveness, especially in the early stages of a fast-evolving geopolitical crisis.

Together, these results offer several contributions. They reveal that corporate decisions during geopolitical conflicts are shaped by a complex mix of financial readiness, public accountability, and external political pressures. Methodologically, the combination of multinomial models, survival analysis, and event studies provides a dynamic perspective on both firm behavior and market expectations. Practically, the findings offer guidance to managers navigating geopolitical uncertainty, to investors evaluating firm exposure and risk management, and to policymakers designing sanctions and other pressure mechanisms.

In an era marked by rising geopolitical tensions and stakeholder activism, this study contributes to a growing literature that situates corporate strategy at the intersection of

finance, governance, and global politics. Future work could explore longer-term reputational impacts, differences in response across regions and sectors, or the role of informal networks and institutional investors in shaping firms' crisis responses.

3.7 Appendices

Variable Definitions

Table 3.11: Degree of Withdrawal, Country and Industry Variables

Variable	**Description**	**Source**
Withdraw	=1 if the firm withdrew and exited from Russia,	KSE Institute
Suspension	=1 if the firm suspended or scaling back its activities in Russia,	KSE Institute
Continue Operation	=1 if the firm continued operations in Russia,	KSE Institute
Announcement date	Earliest disclosed date of the firm's withdrawal or suspension action in response to the Russia-Ukraine war.	KSE Institute
NATO	Dummy = 1 if firm's home country is a NATO member	NATO official website
Distance	indicates the distance between the country's capital and Moscow	Author Calculations
No. Sanction	indicates the number of sanctions imposed by a country agianst Russia within one month after the war	News and OpenAI
Oil Reliance	indicates the percentage of oil reliancy of a country on russia	International Energy Agency (IEA)
Import	indicates the percentage of country imports from Russia by the firm or home country	World Integrated Trade Solution
Export	indicates the percentage of country exports to Russia by the firm or home country	World Integrated Trade Solution
ExIm Ratio	indicates the percentage of country exports to Russia by the firm or home country	World Integrated Trade Solution
Legal	indicates the percentage of country exports to Russia by the firm or home country	PCA Calculations
Trade	indicates the percentage of country exports to Russia by the firm or home country	PCA Calculations
Consumer-Facing	categorical variable	Fama-French 12 Industry Portfolios

Table 3.12: Firm Characteristics

Variable	**Description**	**Source**
Log-MarketCap	Natural log of market capitalization	Orbis
Log-Asset	Natural log of total firm assets	COMPUSTAT
Log-Sale	Natural log of total firm sales/revenue	COMPUSTAT
ROA	Return on assets: net income divided by total assets	COMPUSTAT
LEV	Leverage: total debt divided by total assets	COMPUSTAT
Cash-Ratio	Ratio of cash to total assets	COMPUSTAT
Dividend	Dummy = 1 if firm paid dividends in last fiscal year	COMPUSTAT
ESG-Score	Composite ESG performance score	Refinitiv ESG
Social	ESG subscore: firm's performance on social factors	Refinitiv ESG
Governance	ESG subscore: governance practices	Refinitiv ESG
Environment	ESG subscore: environmental performance	Refinitiv ESG
Log-Instagram	Log of firm's followers on Instagram (proxy for public exposure)	Instagram API
Log-Twitter	Log of firm's followers on Twitter	Twitter API
Log-Google	Log of Google Search volume index (firm name)	Google Trends
Social Media	PCA of insta-google-twitter	Refinitiv ESG
Russia-beta	Sensitivity of firm returns to Russian market index returns (regression beta)	Author's calculation
B2C	Dummy = 1 if firm's Russia-related activity is business-to-consumer	KSE Institute +OpenAI
Upstream	Dummy = 1 if firm imports from Russia (upstream relationship)	KSE Institute + OpenAI

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