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New Research

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Digital Transformation and Firm Environmental Performance: Does Managerial Overseas Experience Matter?

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Abstract

Digital transformation and firm environmental performance have emerged as central topics in the field of corporate sustainability. However, few publications have explored how managerial characteristics influence this relationship. This paper aims to address this gap by examining the impact of digital transformation on firm environmental performance, with a particular focus on the moderating role of managerial overseas experience. Using a sample of Chinese listed companies from 2011 to 2021, we employ robust econometric models to analyse the effects and variations across firms. Our findings reveal that digital transformation significantly enhances firm environmental performance. This positive impact is more pronounced in non-high-pollution firms compared to high-pollution firms. Furthermore, we identify managerial overseas experience as a critical moderating factor, strengthening the positive relationship between digital transformation and firm environmental performance. This study provides valuable insights for firms pursuing sustainable development strategies through digital transformation, emphasizing the importance of managerial overseas experience in achieving improved environmental outcomes.

Keywords: digital transformation, firm environmental performance, managerial overseas experience, China

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Introduction

As global concerns about environmental sustainability intensify, firms face increasing pressure to address environmental performance while maintaining competitive advantage. Against this backdrop, digital transformation has emerged as a transformative force, enabling firms to innovate, optimize operations, and pursue sustainable development goals [1; 2]. By integrating advanced technologies such as artificial intelligence, big data, cloud computing, and blockchain into their business processes, firms can reduce resource consumption, improve operational efficiency, and enhance transparency, thereby driving significant improvements in environmental outcomes [3]. However, while the literature increasingly acknowledges the role of digitalization in fostering sustainability, the specific mechanisms and contextual factors shaping this relationship remain insufficiently explored.

One critical yet underexamined factor is the role of managerial overseas experience. Managers with international exposure bring unique insights, diverse perspectives, and a global mindset to decision-making, which can influence how firms leverage digital transformation for environmental performance. The Upper Echelons Theory [4] suggests that managerial overseas experience can enhance firms' ability to adopt and implement advanced digital technologies in ways that align with environmental goals. These managers are more likely to recognize the long-term strategic benefits of environmental initiatives, adopt international best practices, and embrace stakeholder-driven sustainability standards [5]. However, empirical evidence on whether and how managerial overseas experience moderates the digital transformation – environmental performance relationship remains scarce.

Furthermore, firms face varying degrees of environmental challenges depending on their industry characteristics. In high-pollution industries, such as manufacturing or energy, firms may prioritize short-term financial gains over long-term environmental improvements, limiting the potential benefits of digital transformation [6]. In contrast, non-high-pollution firms often operate under less intense environmental scrutiny and are better positioned to capitalize on the efficiencies and innovations enabled by digitalization. These industry variations raise important questions about the differential impact of digital transformation on firm environmental performance.

To address these gaps, this study empirically examines the relationship between digital transformation and firm environmental performance, with a particular focus on the moderating role of managerial overseas experience. Using a comprehensive dataset of Chinese listed firms from 2011 to 2021, we reveal that digital transformation significantly enhances firm environmental performance. Notably, this positive effect is more pronounced in non-high-pollution firms compared to high-pollution firms. Furthermore, managerial overseas experience positively moderates this relationship, amplifying the environmental benefits of digital transformation.

This study makes several important contributions to the existing literature. First, it provides robust empirical evidence on the role of digital transformation in improving firm environmental performance, advancing the understanding of how digital technologies drive sustainability outcomes. This adds to the growing body of research emphasizing the strategic importance of digitalization for addressing environmental challenges. Second, our analysis identifies managerial overseas experience as a critical moderating factor, offering fresh insights into the role of leadership characteristics in facilitating the successful implementation of digital strategies for sustainability. By doing so, it highlights the significance of globalized managerial perspectives in shaping environmental outcomes. Third, this study underscores the importance of industry heterogeneity by demonstrating that the positive impact of digital transformation on environmental performance is more evident in non-high-pollution industries. This finding provides a nuanced understanding of the contextual factors influencing the environmental benefits of digitalization, offering valuable implications for industry-specific policy and managerial strategies.

The remainder of this paper is structured as follows. Second section reviews the relevant literature and theoretical foundations, leading to the development of hypotheses. Third section outlines the data, variable construction, and empirical methodology. Fourth section presents the results, including robustness checks, and discusses the findings. Finally, fifth section concludes the study and suggests avenues for future research.

Theoretical Foundations and Hypothesis Development

Resource-Based Theory

The resource-based view (RBV) is a foundational theory in strategic management that emphasizes the role of firm-specific resources and capabilities in achieving and sustaining competitive advantage [7]. According to RBV, resources that are valuable, rare, inimitable, and non-substitutable form the basis for long-term performance and differentiation in competitive markets. These resources can include tangible assets, intangible assets, and organizational capabilities that enable firms to effectively exploit opportunities and mitigate threats in their environments [8].

Within the RBV framework, technological advancements, particularly digital transformation, are increasingly recognized as strategic resources that can unlock operational efficiencies, promote innovation, and address environmental challenges [9]. Digital transformation, defined as the integration of advanced digital technologies – such as big data, artificial intelligence, cloud computing, and blockchain – into firms' operations, equips organizations with dynamic capabilities to optimize resource utilization and improve sustainability outcomes. By enabling firms to transform business processes and manage resources more efficiently, digital transformation serves as a strategic tool to enhance

environmental performance, aligning with the core tenets of RBV.

Upper Echelons Theory

The Upper Echelons Theory (UET), introduced by Hambrick and Mason (1984) [4], posits that organizational outcomes – such as strategies, performance, and innovation – are significantly influenced by the demographic and experiential characteristics of top managers. According to UET, managerial decisions are not purely rational but are shaped by cognitive frames, values, and experiences, which arise from factors such as age, education, functional background, and international exposure [10]. These characteristics serve as filters through which managers perceive challenges, evaluate opportunities, and formulate strategies, ultimately determining firm performance and strategic direction.

Among the various managerial traits, overseas experience is increasingly recognized as a key determinant of managerial cognition and decision-making capabilities. Managers with overseas backgrounds are exposed to diverse institutional environments, global best practices, and advanced technologies, which broaden their cognitive scope and enhance their ability to identify strategic opportunities. In the context of digital transformation and environmental performance, managerial overseas experience equips top executives with a global mindset, fostering greater awareness of sustainability imperatives and innovative pathways to achieve environmental goals [11]. Thus, UET provides a robust theoretical lens to understand how managers' international exposure moderates the relationship between corporate digitalization and firm environmental performance.

Hypothesis Development

Direct Effect Hypothesis

RBV provides a strong theoretical foundation for understanding how digital transformation positively influences firm environmental performance. As firms face increasing pressure to achieve environmental sustainability, their ability to leverage unique and strategic resources becomes critical. Digital transformation, as a technological and organizational resource, enhances firms' capabilities to reduce environmental impact through improved operational efficiency, innovation, and resource optimization.

First, digital transformation facilitates efficient resource management, which directly supports environmental sustainability. Advanced digital technologies, such as big data analytics and artificial intelligence, enable firms to monitor and optimize energy consumption, emissions, and resource utilization in real time [12]. By providing granular insights into operational inefficiencies, these technologies empower firms to adopt cleaner production methods and reduce their environmental footprint. For instance, big data analytics allows firms to identify patterns in energy usage, while artificial intelligence optimizes production processes to minimize waste and emissions [13]. Such efficiency gains align with RBV, as firms with superior technological capabilities are better positioned to capitalize on these resources to improve environmental performance.

Second, digital transformation promotes technological innovation, a key driver of sustainable environmental practices. According to RBV, innovation capabilities are critical for firms to develop and sustain competitive advantages in dynamic environments [14]. Digital technologies enable firms to invest in green innovations, such as eco-friendly products, low-carbon technologies, and circular economy practices. Cloud computing, for example, reduces firms' reliance on energy-intensive physical infrastructure by enabling virtualized systems, while blockchain enhances transparency and traceability in supply chains, ensuring compliance with environmental regulations [15]. Firms that leverage these innovative capabilities can gain a first-mover advantage in addressing environmental challenges, further supporting the RBV assertion that strategic resources drive firm-level outcomes.

Third, digital transformation enhances firms' dynamic capabilities, enabling them to respond to external environmental pressures and institutional demands effectively. Firms operating in resource-constrained environments face challenges in balancing economic growth with environmental sustainability. However, digital transformation equips firms with the ability to sense, seize, and transform environmental opportunities by integrating digital solutions into their strategic planning and operations. For example, digital platforms enhance firms' ability to engage with stakeholders, disclose environmental performance, and comply with regulatory requirements, further aligning firm strategies with sustainability goals [16]. According to RBV, such capabilities are essential for firms to adapt to evolving environmental standards and maintain long-term competitiveness. Thus, we propose the following hypothesis:

H1: Digital transformation has a positive and significant effect on firm environmental performance.

Moderating Effect Hypothesis

UET suggests that managers' characteristics, such as overseas experience, influence their ability to perceive and leverage strategic opportunities [17]. In the context of digital transformation, managerial overseas experience provides exposure to international best practices and environmental standards, which can influence how managers guide firms in deploying digital technologies for sustainability purposes. Importantly, while overseas experience may not independently lead to improved environmental performance – especially when misaligned with local operational contexts – it can serve as an important contextual enabler, strengthening the positive effects of digital transformation on firm environmental performance.

First, managers with overseas experience tend to possess a broader cognitive framework, allowing them to better identify and interpret the environmental value of digital transformation. Their familiarity with advanced digital applications – such as AI for emissions forecasting or big data for energy optimization – enhances their ability to amplify

the environmental benefits of digital investments [18–21]. In this sense, overseas experience does not act as a direct driver of sustainability, but as a catalyst that enhances the strategic utility of digital tools.

Second, international exposure often brings with it a heightened sensitivity to long-term environmental objectives and stakeholder expectations, especially in jurisdictions with strict environmental regulations [22–24]. Managers with such backgrounds are better positioned to align digital transformation initiatives with emerging regulatory frameworks and sustainability norms, thereby elevating the effectiveness of digital transformation in addressing environmental challenges.

Third, managerial overseas experience enhances firms' dynamic capabilities, which are critical for navigating the complexities of digital transformation and sustainability [25]. Managers with international exposure are adept at sensing, seizing, and transforming opportunities within rapidly changing technological and environmental landscapes. For instance, they are more likely to adopt digital innovations, such as blockchain for supply chain transparency or cloud computing for energy-efficient operations, to improve environmental performance [26]. Their global perspective also facilitates cross-border knowledge transfer and collaboration, enabling firms to integrate cutting-edge digital practices that magnify the ecological value of digital transformation.

All in all, we argue that managerial overseas experience plays a complementary and reinforcing role in the digital transformation – environmental performance relationship, serving as a strategic asset that conditions the success of digital initiatives aimed at sustainability.

H2: Managerial overseas experience positively moderates the relationship between digital transformation and firm environmental performance.

Heterogeneous Effect Hypothesis

RBV posits that firms' competitive advantages are derived from resources and capabilities that are valuable, rare, inimitable, and non-substitutable [27]. Firms with superior capabilities are better positioned to optimize resources and adapt to changing market or institutional demands. Digital transformation, as a strategic resource, enables firms to achieve operational efficiency, optimize resource utilization, and foster environmental innovations, thereby improving firm environmental performance [28]. However, the extent to which digital transformation enhances environmental performance depends on firms' resource flexibility and environmental constraints, which differ significantly between high-pollution and non-high-pollution firms.

First, non-high-pollution firms typically exhibit greater resource flexibility, allowing them to harness the benefits of digital transformation more effectively to improve environmental performance. Digital transformation facilitates precise resource allocation, energy optimization, and waste reduction through technologies such as big data analytics and artificial intelligence [29]. Non-high-pollution firms, facing lower regulatory compliance costs and fewer legacy constraints, can allocate more resources toward integrating digital technologies for proactive environmental management [30]. In contrast, high-pollution firms often divert resources toward mandatory pollution control and regulatory compliance, which limits their ability to leverage digital transformation for innovation and process optimization fully [29–30].

Second, digital transformation provides firms with the capability to pursue green innovation, a critical pathway to environmental performance improvement. Non-high-pollution firms are less burdened by immediate environmental pressures that constrain innovation investments in high-pollution industries [31]. These firms can leverage digital technologies to develop sustainable products, implement cleaner production processes, and adopt circular economy models, aligning with RBV's emphasis on innovation as a source of competitive advantage. By contrast, high-pollution firms often focus on meeting baseline environmental standards, leaving little room for investments in proactive and innovative environmental strategies driven by digital transformation. This leads to the following hypothesis:

H3: The positive impact of digital transformation on firm environmental performance is stronger in non-high-pollution firms than in high-pollution firms.

Methodology

Sample and Data

This study utilizes a comprehensive dataset of 1,316 Chinese A-share listed firms spanning the period from 2011 to 2021. The data for executive characteristics and financial indicators were meticulously extracted from the China Stock Market and Accounting Research (CSMAR) database, while firm environmental performance data were obtained from the Bloomberg database, which is widely recognized for its reliability in ESG-related research.

To ensure the rigour, relevance, and robustness of the dataset, a systematic data preprocessing procedure was employed. First, firms in the financial industry were excluded due to their distinct governance structures and regulatory frameworks, which could introduce bias into the analysis. Second, companies designated as "ST" (Special Treatment) by the China Securities Regulatory Commission (CSRC) – indicating financial distress for two consecutive years – were removed to minimize the influence of severely underperforming firms on the results. Third, firms lacking sufficient financial or accounting information were excluded to preserve the completeness and consistency of the dataset. Fourth, to mitigate the impact of outliers that could distort statistical inferences, all continuous variables were subjected to winsorization at the 1st and 99th percentiles. This technique effectively controls for extreme values while maintaining the integrity of the data distribution. After the above procedures

were applied, the final sample comprised 10,593 firm-year observations. The resulting panel is unbalanced due to variations in listing dates and missing values across years. This structure is common in empirical corporate finance studies and allows for the retention of a larger and more representative sample without introducing selection bias.

Variable Measurement and Estimations Techniques

The dependent variable in this study is firm environmental performance, proxied by environmental rating scores from the Bloomberg database. These scores comprehensively evaluate a firm's environmental practices, encompassing aspects such as resource efficiency, carbon emissions, energy consumption, waste management, and environmental disclosures. Derived from publicly available sustainability reports and independent third-party sources, Bloomberg's ratings ensure objectivity and comparability across firms and industries. By reflecting multiple dimensions of environmental performance over time, these standardized scores serve as a robust and dynamic proxy for assessing firms' environmental outcomes [33; 34].

The independent variable in this study is digital transformation, which reflects the extent to which firms adopt and integrate advanced digital technologies into their strategic operations. Digital transformation involves the deployment of technologies such as artificial intelligence (AI), big data (BD), cloud computing (CC), blockchain (BC), and digital technology applications (DTA) to optimize business processes, improve decision-making, and enhance operational efficiency. Given the strategic importance of digital transformation, this study relies on firms' annual reports – particularly the Management Discussion and Analysis (MD&A) sections – as a primary source to capture their engagement with digital initiatives.

To measure digital transformation, we take a textual analysis approach using advanced natural language processing (NLP) techniques. First, the Jieba segmentation tool is used to perform precise word segmentation on Chinese corporate texts. Next, we apply Word2Vec models (CBOW and Skip-Gram) to identify and embed digital transformation-related terms, ensuring that the measure captures both frequent and contextually nuanced keywords. The digital transformation index is constructed by calculating the logarithmic transformation of the frequency of these keywords in each firm's MD&A section. This methodology not only overcomes the limitations of traditional keyword-based approaches but also ensures greater semantic accuracy and robustness, providing a comprehensive and dynamic measure of firms' digital transformation levels.

The moderating variable in this study is managerial overseas experience, which reflects whether a firm's top executives have international work or educational backgrounds. This variable is constructed as a dummy variable (binary indicator): it takes the value 1 if at least one member of the top management team (TMT) – such as the CEO, board chairperson, or other senior executives – has studied or worked overseas, and 0 otherwise.

To control for potential confounding factors that may influence the relationship between digital transformation and firm environmental performance, this study includes a set of control variables widely adopted in the existing literature [35; 38]. Listing age (LA) is measured as the natural logarithm of the number of years since a firm's initial public offering, accounting for firm maturity and experience. Financial leverage (LEV), defined as the ratio of total debt to total assets, reflects a firm's capital structure, as higher debt levels may constrain investments in digital transformation and environmental initiatives. Return on equity (ROE), calculated as net income divided by total shareholders' equity, serves as a proxy for profitability, with financially successful firms being more capable of adopting advanced digital technologies to improve sustainability outcomes. Cash holdings (CH), measured as the ratio of cash and cash equivalents to total assets, capture firm liquidity, which can facilitate or limit resource allocation toward digital transformation and environmental efforts. With regard to corporate governance, board size (BS), measured as the total number of directors on the board, reflects governance capacity and decision-making structure, while the proportion of independent directors (ID) captures board independence and its ability to monitor managerial actions. Ownership concentration (OC), defined as the percentage of shares held by the largest shareholder, indicates the degree of shareholder control, which may influence firms' strategic priorities, including environmental sustainability. Finally, managerial ownership (MO), measured as the percentage of shares held by senior management, aligns managerial interests with shareholders, potentially motivating executives to pursue long-term digitalization and environmental goals.

To test hypothesis H1–H3, we construct the following empirical models:

$$\begin{aligned} FEP_{i,t} &= \alpha_0 + \alpha_1 DT_{i,t} + \alpha_2 LA_{i,t} + \alpha_3 LEV_{i,t} + \\ &+ \alpha_4 ROE_{i,t} + \alpha_5 CH_{i,t} + \alpha_6 BS_{i,t} + \alpha_7 ID_{i,t} + \\ &+ \alpha_8 OC_{i,t} + \alpha_9 MO_{i,t} + Year + Firm + \varepsilon, \end{aligned} \quad (1)$$

$$\begin{aligned} FEP_{i,t} &= \alpha_0 + \alpha_1 DT_{i,t} + \alpha_2 MOE_{i,t} + \\ &+ \alpha_3 DT_{i,t} * MOE_{i,t} + \alpha_4 LA_{i,t} + \alpha_5 LEV_{i,t} + \\ &+ \alpha_6 ROE_{i,t} + \alpha_7 CH_{i,t} + \alpha_8 BS_{i,t} + \alpha_9 ID_{i,t} + \\ &+ \alpha_{10} OC_{i,t} + \alpha_{11} MO_{i,t} + Year + Firm + \varepsilon. \end{aligned} \quad (2)$$

where α_0 denotes the intercept, and $\alpha_1 - \alpha_{11}$ the coefficients to be estimated. *Year* and *Firm* are dummy variables that control for year and firm fixed effects to account for unobserved, time-invariant firm-specific characteristics that may influence the dependent variable; ε is the error term; i denotes the cross-sectional dimension for firms; and t denotes the time series dimension.

Equation (1) is used to test the direct effect and the heterogeneity effect, while Equation (2) is aimed at examining the moderating role of MOE.

Findings and Discussion

Descriptive Statistics and Correlation Matrix

Table 1 presents the descriptive statistics for the variables used in this study, based on 10,593 firm-year observations, computed using Stata 17. The dependent variable, Firm Environmental Performance (FEP), has a mean value of 8.900, with a relatively large standard deviation of 12.250, indicating significant variation across firms. The values range from 0 to a maximum of 73.815, suggesting that some firms perform exceptionally well in environmental practices while others lag behind.

The key independent variable, Digital Transformation (DT), has a mean of 1.393 and a standard deviation of 1.386, with values ranging from 0 to 6.301, reflecting varying levels of digital technology adoption among firms. The moderating variable, Managerial Overseas Experience (MOE), is a binary indicator with a mean of 0.630, suggesting that 63% of the firms' executives possess overseas backgrounds.

Among the control variables, Listing Age (LA), measured as the logarithmic number of years since listing, shows a mean of 2.478 with a standard deviation of 0.676 and ranges between 0 and 3.367. Leverage (LEV) averages 0.478, reflecting that firms finance 47.8% of their assets with debt, and has a relatively low dispersion (standard deviation of 0.199). Return on Equity (ROE) has a mean value of 0.087 yet displays notable variation, with a standard deviation of 0.128 and extreme values ranging from -0.926 to 0.419, suggesting profitability disparities across firms. Cash Holdings (CH) exhibit a mean of 0.059 and a standard deviation of 0.069, with values ranging between -0.199 and 0.257, indicating varying levels of liquidity among firms. Board Size (BS), expressed as the natural logarithm of the number of board members, has a mean of 2.175 and a low standard deviation of 0.201, with values between 1.609 and 2.708. Independent Directors (ID), measured as the percentage of independent directors on the board, has a mean of 37.534% with notable variation (standard deviation of 5.503) and ranges from 28.570% to 60.000%. Ownership Concentration (OC), defined as the percentage of shares held by the largest shareholder, averages 36.821%, with significant dispersion (standard deviation of 16.104) and a wide range from 8.087% to 75.779%. Finally, Managerial Ownership (MO) has a mean value of 7.079% with substantial variability (standard deviation of 14.884) and ranges from 0 to 70.382%, indicating considerable heterogeneity in managers' equity stakes across firms.

Overall, these statistics reveal substantial variation across firms in terms of environmental performance, digital transformation, managerial characteristics, and governance indicators.

Table 2 presents the results of the Pearson correlation analysis and Variance Inflation Factor (VIF) diagnostics for the key variables in this study. The correlation analysis focuses on the relationships between the independent variable (digital transformation), the moderating variable (managerial overseas experience), and the dependent variable (firm environmental performance). The results show that DT is positively and significantly correlated with FEP ($r = = 0.070$, $p < 0.01$), indicating a preliminary positive association between DT and firms' environmental outcomes. Similarly, the moderating variable (MOE) exhibits a significant positive correlation with FEP ($r = 0.108$, $p < 0.01$), suggesting that firms with managers possessing overseas experience tend to achieve better environmental performance. Furthermore, DT and MOE are positively correlated ($r = 0.124$, $p < 0.01$), implying that managerial overseas experience may enhance the effectiveness of digital transformation in improving environmental performance.

Table 1. Descriptive Statistics

Variable	Definition	Obs	Mean	Std. dev.	Min	Max
FEP	Firm Environmental Performance	10.593	8.900	12.250	0.000	73.815
DT	Digital Transformation	10.593	1.393	1.386	0.000	6.301
MOE	Managerial Overseas Experience	10.593	0.630	0.483	0.000	1.000
LA	Listing Age	10.593	2.478	0.676	0.000	3.367
LEV	Leverage	10.593	0.478	0.199	0.032	0.908
ROE	Return on Equity	10.593	0.087	0.128	-0.926	0.419
CH	Cash Holdings	10.593	0.059	0.069	-0.199	0.257
BS	Board Size	10.593	2.175	0.201	1.609	2.708
ID	Independent Directors	10.593	37.534	5.503	28.570	60.000
OC	Ownership Concentration	10.593	36.821	16.104	8.087	75.779
MO	Managerial Ownership	10.593	7.079	14.884	0.000	70.382

Source: calculated by authors.

Table 2. Pearson Correlation and Variance Inflation Factor

	FEP	DT	MOE	LA	LEV	ROE	CH	BS	ID	OC	MO	VIF
FEP	1.000											
DT	0.070***	1.000										1.06
MOE	0.108***	0.124***	1.000									1.04
LA	0.036***	-0.061***	-0.096***	1.000								1.42
LEV	0.046***	-0.082***	-0.022**	0.261***	1.000							1.21
ROE	0.065***	0.026***	0.038***	-0.161***	-0.218***	1.000						1.20
CH	0.108***	0.013	0.025***	-0.088***	-0.251***	0.361***	1.000					1.20
BS	0.037***	-0.094***	0.050***	0.090***	0.123***	-0.014	0.004	1.000				1.34
ID	0.036***	0.054***	0.003	-0.015	-0.000	0.020**	0.019*	-0.454***	1.000			1.28
OC	0.035***	-0.146***	-0.057***	-0.076***	0.085***	0.112***	0.069***	0.023**	0.072***	1.000		1.11
MO	-0.029***	0.133***	0.091***	-0.495***	-0.268***	0.122***	0.073***	-0.186***	0.034***	-0.152***	1.000	1.47

Note: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

To further assess multicollinearity, VIF values were calculated for all explanatory variables. The results indicate that multicollinearity is not a concern, as all VIF values are well below the critical threshold of 10. Specifically, the VIF values for DT and MOE are 1.06 and 1.04, respectively, suggesting very low collinearity. The highest VIF value, 1.47, is observed for managerial ownership (MO), which remains within acceptable limits. Overall, the combination of correlation and VIF results confirms that the regression models are free from multicollinearity issues, ensuring the robustness and reliability of the empirical analysis.

Baseline Results

Table 3 presents the baseline regression results for the impact of DT on FEP. In column (1), the key independent variable DT demonstrates a positive and highly significant relationship with FEP, indicating that digital transformation plays a crucial role in enhancing firms' environmental performance. This positive relationship remains robust, though with a slight reduction in magnitude, even after the inclusion of additional control variables in column (2).

The control variables included in column (2) provide further insights into the determinants of firm environmental performance. Firm characteristics, such as listing age, indicate that older firms, benefiting from accumulated experience and resources, tend to achieve better environmental outcomes. In contrast, firms with higher leverage may face financial constraints that limit their capacity to invest in sustainability initiatives. Profitability, reflected in return on equity, positively influences FEP, as financially sound firms are more capable of implementing environmental strategies. Corporate governance variables, such as board size, proportion of independent directors, ownership concentration, and managerial ownership, all exhibit positive associations with environmental performance, underscoring the importance of governance structures and aligned interests in supporting firms' environmental efforts. Collectively, these findings highlight that financial strength, experience, and governance quality play pivotal roles in driving firms' environmental outcomes alongside digital transformation.

Overall, the results strongly support Hypothesis 1 (H1), which posits that digital transformation positively influences firm environmental performance. These findings are consistent with RBV, which emphasizes that firms' valuable, rare, inimitable, and non-substitutable resources – such as digital technologies – can generate competitive advantages [30; 35]. By integrating advanced technologies like artificial intelligence, big data, and cloud computing, firms can enhance operational efficiency, reduce emissions, and achieve environmental sustainability [31]. The results align with prior studies that link digital transformation to improved environmental practices through innovation, resource optimization, and supply chain transparency [23; 28; 29]. Furthermore, the findings suggest that firms with stronger governance mechanisms are better positioned to exploit digital technologies, reinforcing the RBV argument that organizational resources and capabilities underpin environmental performance [39].

Robustness Check

To ensure the reliability and consistency of the baseline results, we conduct several robustness checks (Table 4). Specifically, three approaches are employed: adding year-industry interaction fixed effects, replacing the independent variable with an alternative measure, and incorporating additional control variables.

First, column (1) incorporates year-industry interaction fixed effects to account for unobserved heterogeneity that may vary simultaneously across time and industry. This approach is particularly useful for controlling for time-vary-

Table 3. Baseline Regression Results

	(1) FEP	(2) FEP
DT	0.387***	0.351***
	(0.129)	(0.128)
LA		3.116***
		(0.541)
LEV		-1.762*
		(0.917)
ROE		4.577***
		(0.708)
CH		0.447
		(1.380)
BS		2.939***
		(0.887)
ID		0.114***
		(0.027)
OC		0.040***
		(0.015)
MO		0.043***
		(0.016)
_cons	8.286***	-11.439***
	(0.192)	(3.019)
Year FE	yes	yes
Firm FE	yes	yes
N	10531	10531
Adj. R^2	0.646	0.650

Note: * p < 0.1, ** p < 0.05, *** p < 0.01. Robust standard errors are given in parentheses.

Table 4. Robustness Check

	(1) FEP	(2) FEP	(3) FEP	(4) FEP	(5) FEP
DT	0.342***		0.349***	0.344***	0.275**
	(0.130)		(0.128)	(0.128)	(0.126)
DT-dummy		0.411*			
		(0.235)			
LA	3.212***	3.181***	3.118***	3.056***	3.702***
	(0.548)	(0.540)	(0.541)	(0.542)	(0.524)
LEV	-1.857**	-1.692*	-1.707*	-1.930**	-3.393***
	(0.916)	(0.916)	(0.919)	(0.920)	(0.890)
ROE	4.501***	4.617***	4.128***	4.244***	4.237***
	(0.716)	(0.707)	(0.903)	(0.722)	(0.689)
CH	0.338	0.367	0.483	0.232	0.028
	(1.381)	(1.381)	(1.379)	(1.384)	(1.358)
BS	2.900***	3.011***	2.945***	2.867***	2.142**
	(0.892)	(0.887)	(0.887)	(0.889)	(0.866)
ID	0.107***	0.112***	0.114***	0.114***	0.100***
	(0.027)	(0.027)	(0.027)	(0.027)	(0.026)
OC	0.041***	0.039***	0.040***	0.040***	0.047***
	(0.015)	(0.015)	(0.015)	(0.015)	(0.015)
MO	0.053***	0.043***	0.043***	0.044***	0.034**
	(0.016)	(0.016)	(0.016)	(0.016)	(0.015)
LOSS			-0.290		
			(0.351)		
MFEE				-4.437**	
				(1.824)	
SA					24.432***
					(1.974)
_cons	-11.378***	-11.469***	-11.411***	-10.666***	83.154***
	(3.057)	(3.026)	(3.020)	(3.051)	(7.867)
Year FE	yes	yes	yes	Yes	yes
Firm FE	yes	yes	yes	Yes	yes
Year * Industry	yes	no	no	No	no
N	10531	10531	10531	10531	10531
Adj. R^2	0.653	0.650	0.650	0.650	0.662

Note: * p < 0.1, ** p < 0.05, *** p < 0.01. Robust standard errors are given in parentheses.

ing industry-specific shocks, as it captures any systematic variation in FEP attributable to interactions between industry-level factors and temporal trends. The coefficient of DT remains positive and significant, further confirming the robustness of the baseline results.

Second, column (2) replaces the continuous measure of digital transformation (DT) with a dummy variable (DT-dummy), which equals 1 if a firm's digital transformation index is above the sample median and 0 otherwise. This test checks whether the relationship between digital transformation and FEP holds when one uses a simplified binary measure of digitalization. The results indicate that DT-dummy maintains a positive and significant effect on FEP, reinforcing the robustness of the baseline findings to alternative variable specifications.

Third, columns (3) to (5) introduce additional control variables to address concerns about omitted variable bias. Specifically, firm losses (LOSS), management expense ratio (MFEE), and financing constraints (SA index) are included. Firm losses, measured as a dummy variable equal to 1 for firms reporting negative net profits, are controlled because financial distress can limit investments in sustainability initiatives, thereby influencing environmental performance [40]. The management expense ratio (MFEE), calculated as the ratio of management expenses to revenue, serves as a proxy for agency costs, which may affect managerial efficiency in implementing digital transformation strategies [41]. Finally, the SA index, a widely used measure of financing constraints, is included to control for firms' financial flexibility, as constrained firms may struggle to adopt costly digital technologies for environmental improvements [42].

The results in columns (3)–(5) demonstrate that the positive effect of DT on FEP remains significant even after including these additional controls. While firm losses (LOSS) are not statistically significant, both management expense ratio (MFEE) and SA index show significant effects, suggesting that agency costs and financial constraints play critical roles in shaping firms' environmental performance. Significantly, the coefficient for DT remains robust across all specifications, further supporting the validity of the main findings.

In conclusion, these robustness checks – using year-industry interaction fixed effects, alternative measures of digital transformation, and additional controls – confirm that the positive relationship between digital transformation and firm environmental performance is both consistent and reliable. The findings underscore the critical role of digital technologies in driving environmental outcomes, even under varying model assumptions.

Moderating Role of Managerial Overseas Experience

As shown in Table 5, the interaction term c.DT#c.MOE is significantly positive (α_2 = 0.454, $p < 0.05$ in model (1); α_2 = 0.434, $p < 0.05$ in model (2)), indicating that MOE strengthens the positive relationship between DT and FEP. This suggests that firms with internationally experienced managers are better positioned to leverage digital technologies for environmental outcomes, as their global perspectives enable more effective integration of advanced digital strategies into sustainability initiatives.

These findings support Hypothesis 2 (H2) and align with the predictions of the Upper Echelons Theory [17], which

Table 5. Moderating Effect

	(1) FEP	(2) FEP
DT	0.372**	0.337*
	(0.185)	(0.185)
MOE	-0.578	-0.559
	(0.366)	(0.364)
c.DT#c.MOE	0.454**	0.434**
	(0.220)	(0.219)
LA		3.043***
		(0.888)
LEV		-1.784
		(1.416)
ROE		4.525***
		(0.920)
CH		0.452
		(1.610)
BS		3.071**
		(1.336)
ID		0.116***
		(0.039)
OC		0.039*
		(0.023)
MO		0.045*
		(0.025)
_cons	8.633***	-11.252**
	(0.332)	(4.628)
Year FE	yes	yes
Firm FE	yes	yes
N	10531	10531
Adj. R^2	0.647	0.651

Note: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Robust standard errors are given in parentheses.

emphasizes that executives' experience shapes their strategic decisions and ability to leverage organizational resources. Managers with overseas backgrounds bring a global mindset and exposure to advanced sustainability practices, allowing them to better recognize and implement digital technologies such as AI and big data to improve environmental performance [34; 42]. These results are consistent with prior studies which show that international experience enhances firms' innovation and sustainability efforts [5; 20]. While the direct negative effect of MOE may reflect challenges in aligning global strategies with local contexts, its significant interaction with digital transformation underscores its critical enabling role in amplifying environmental benefits.

Heterogeneity Analysis

The heterogeneity analysis in Table 6 examines the differential impact of DT on FEP across high-pollution firms (High Pollution = 1) and non-high-pollution firms (High Pollution = 0).

In column (1), which represents high-pollution firms, the coefficient for DT is negative but not statistically significant. This result suggests that digital transformation does not significantly enhance environmental performance for firms in highly polluting industries. One possible explanation is that high-pollution firms often face rigid regulatory pressures, legacy systems, and higher transition costs, which may limit their ability to leverage digital technologies effectively for environmental improvements.

In contrast, column (2) shows a significantly positive coefficient for DT in non-high-pollution firms ($\beta = 0.713$, $p < 0.01$), indicating that digital transformation significantly improves environmental performance in these firms. Non-high-pollution firms, which generally face fewer regulatory constraints and operate in less resource-intensive environments, are better positioned to adopt and integrate advanced digital technologies such as big data, AI, and cloud computing to optimize operations and achieve environmental efficiency.

These findings support Hypothesis 3 (H3), which predicts that the positive impact of digital transformation on firm environmental performance is stronger in non-high-pollution firms compared to high-pollution firms. The results align with RBV, which posits that firms must strategically deploy valuable resources, such as digital technologies, to enhance performance [32; 43]. Non-high-pollution firms are better able to capitalize on digital transformation due to lower technological adaptation costs and fewer structural barriers. Consistent with prior studies, Zhang et al. (2023) [44] argue that firms in less resource-intensive industries can implement digital solutions more efficiently to achieve sustainability outcomes, while Firoozi et al. (2024) [45] highlight that digital transformation is more effective in environments with fewer compliance burdens, enabling innovation and resource optimization. In contrast, high-pollution firms face substantial financial and operational hurdles during their transition to digital processes [46], which limits the environmental benefits of digitalization. The insignificant result for high-pollution firms also reflects the challenges of path dependence in environmentally intensive industries, where reliance on outdated technologies and strict regulatory pressures reduce flexibility for adopting innovative, digital-driven solutions. In comparison, non-high-pollution firms are better positioned to integrate digital technologies into their operations, achieving measurable improvements in environmental performance.

Table 6. Heterogeneity Analysis

	High Pollution =1 (1)	High Pollution=0 (2)
	FEP	FEP
DT	-0.089	0.713***
	(0.229)	(0.157)
LA	1.960*	3.651***
	(1.071)	(0.629)
LEV	-0.321	-1.964*
	(1.697)	(1.098)
ROE	2.577*	4.349***
	(1.399)	(0.800)
CH	-1.029	1.249
	(2.750)	(1.540)
BS	2.358	3.459***
	(1.667)	(1.021)
ID	0.107**	0.115***
	(0.050)	(0.031)
OC	-0.005	0.057***
	(0.025)	(0.019)
MO	0.011	0.038**
	(0.031)	(0.019)
_cons	-3.318	-15.934***
	(5.863)	(3.421)
Year FE	yes	yes
Firm FE	yes	yes
N	3584	6916
Adj. R^2	0.669	0.641

Note: * p < 0.1, ** p < 0.05, *** p < 0.01. Robust standard errors are given in parentheses.

Conclusion

This study investigates the impact of digital transformation on firm environmental performance while examining the moderating roles of managerial overseas experience and industry heterogeneity. The results confirm that digital transformation significantly enhances firm environmental performance, as advanced technologies like artificial intelligence, big data, and cloud computing enable firms to optimize resource usage and reduce environmental footprints. Further, the moderating effect analysis reveals that managerial overseas experience amplifies this positive relationship, as internationally experienced managers bring a global perspective and familiarity with advanced sustainability practices, enhancing the effectiveness of digital transformation. Heterogeneity tests show that the positive effect of digital transformation on environmental performance is more pronounced in non-high-pollution firms, which face fewer regulatory and structural barriers, while the effect is insignificant in high-pollution firms due to path dependence and the costs of transitioning to cleaner processes. These findings collectively highlight the significant role of digital transformation in improving environmental performance and emphasize the importance of managerial expertise and industry context in shaping its effectiveness.

This study makes several important theoretical contributions. First, it extends the Resource-Based View by demonstrating that digital transformation serves as a valuable strategic resource for firms to achieve environmental sustainability, particularly under favourable organizational and contextual conditions. Second, by integrating the Upper Echelons Theory, we highlight the critical enabling role of managerial overseas experience in enhancing firms' capabilities to utilize digital technologies for environmental improvements. Third, this study contributes to the literature on industry heterogeneity by illustrating how firms operating in different environmental contexts (e.g., high-pollution vs. non-high-pollution industries) show varying degrees of effectiveness in their digital transformation efforts.

The findings offer several practical insights for corporate leaders, policymakers, and stakeholders. For firms, the results emphasize the importance of strategically investing in digital transformation technologies to improve environmental performance. Managers with overseas experience should be actively leveraged to drive these initiatives, as their global perspectives can enhance the effective implementation of sustainability-oriented digital strategies. Firms in high-pollution industries, however, may need additional support, such as targeted policy incentives or financial assistance, to overcome barriers to adopting digital solutions for environmental improvements.

For policymakers, our findings highlight the need to create favourable conditions for firms to invest in digital transformation and leverage managerial expertise. Policies that support technological upgrading and provide regulatory flexibility for high-pollution firms could help them better harness digital technologies for sustainability. Additionally, fostering leadership development programmes that encourage international exposure among corporate managers could amplify the environmental benefits of digital transformation.

Despite its contributions, this study has several limitations. First, the analysis focuses on Chinese publicly listed firms, which may limit the generalizability of the findings to other institutional contexts. Future research could explore cross-country or cross-regional comparisons to provide broader evidence on the relationship between digital transformation and environmental performance. Second, while this study identifies managerial overseas experience as a key moderating factor, other leadership characteristics – such as managerial risk appetite or innovation mindset – could also play a role. Third, further investigation into the mechanisms through which digital transformation impacts environmental performance, such as green innovation or supply chain optimization, could deepen our understanding of these dynamics.

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Typical Uncertainty of Sustainable Growth of ESG Enterprises in a Dynamically Effective Stochastic Economy with Public Debt

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Abstract

The subject of the study is an enterprise based on ESG principles, which implies its concern for the interests of not only the current but also future generations. The study was undertaken to develop a sustainable growth model that takes into account economic uncertainty and is capable of covering a period of time sufficient for ESG program implementation. Despite the widespread desire to achieve sustainable growth, there is no unanimity in regard to the methods of integrating long-term development programs with traditional commitment to current profit maximization. One of the difficulties is associated with reaching intergenerational planning horizons. In addition to their short-term nature, existing sustainable growth models do not include an indicator of the uncertainty associated with the activities of the enterprise. To solve this problem, the paper uses methods of integrating stochastic differential equations, which allows to move away from the deterministic dependencies of predecessor models. The resulting stochastic trend model takes into account the systematic long-term impact of the environment. This approach turns it into a hyper-long-term planning tool commensurate with the duration of the enterprise life cycle. According to this model, the probability density of revenue growth rate is subject to a logarithmically normal law with numerical characteristics changing under the influence of competition and inflation. The paper envisages several development scenarios characterized by different dynamics of the random component. If the enterprise follows ESG principles, then the typical growth scenario will be the most suitable one. The random component of growth of a typical enterprise degenerates over time, and its rate is determined by the risk-free interest rate. From the concept of intersecting generations, it follows that typical enterprises contribute to the dynamic efficiency of the economy.

Keywords: stochastic process, volatility trend, growth rate, financial ratios, hyperlong-term, dynamic efficiency

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Introduction

To ensure sustainable economic development, one has to manage uncertainty that influences key business decisions: amount of investment, expense structure, pricing policy, planning horizon. Modern enterprises attempt to reduce it in various ways: diversification, long-term agreements, subscription for services, hedging of price and exchange rate risks, and also implement sustainable development programs based on ESG principles. The distinctive feature of hedging is its hyper-long-term horizon, which encompasses several generations [1]. Empirical data about the influence of ESG on enterprises' financial performance is ambiguous. A review of the practice of implementation of ESG transformation programs demonstrates a positive effect in 60% of cases, neutral – in 9%, mixed – in 25%, and negative – in 6% [2]. These figures suggest that some companies are unable to implement ESG without damaging the core value measured by profit [3]. It is difficult to transition to the sustainable development track due to the underdevelopment of hyper-long-term planning methods. The existing studies are premised on probability-based models, which can confirm statistical relationships between the analyzed indicators but are unsuitable for operational business planning.

The situation with ESG implementation may be rectified by means of a sustainable development trend model that allows to combine hyper-long-term financial objectives with current indicators [4]. The model describes the enterprise's revenue dynamics over a time interval comparable with its life cycle span. The addition of long-term trends of financial ratios to the model allowed to shift to this modelling horizon. One of possible trend combinations describes how the enterprise moves towards the equilibrium state. However, the trend model fails to take into consideration the economic uncertainty factor, thus, it becomes less feasible. The present research eliminates this gap by adding the standard deviation of revenue to the list of financial ratios. Since the existing empirical data about dynamics of its uncertainty is insufficient, we had to use economic theory when describing this indicator. In order to determine the uncertainty level that corresponds to the enterprise's equilibrium state, we used a stochastic model of intersecting generations with safe assets (public debt) and dynamic efficiency [5]. Exponentiality of uncertainty is introduced similarly to that of other financial ratios of a typical enterprise whose dynamics have been thoroughly studied empirically.

Probability density of financial variables' growth rate often comprises heavy tails, which account for the excessive frequency of extreme events. Since the implementation of ESG programs decreases the enterprises' dependence on rare but strong shocks [6], it seems acceptable to use a lognormal distribution that does not take into account abnormalities of a frequency distribution to describe the revenue growth rate. The existing empirical data proves that this assumption is true in four cases out of seven [7]. It is comparable to the statistics of successful ESG implementation. In spite of the unchanged standard deviation of the logarithm of the revenue growth rate over a long period of time for the majority of enterprises, in a considerable number of cases it tends to decrease gradually. No satisfactory explanation of this volatility phenomenon has been offered yet by corporate finance theory. Along with long-term changes, the influence of short-term external shocks such as economic crises, manufacturing innovations, a sudden change in prices and demand for products, on the uncertainty level has been understudied. Such factors may cause structural changes in dynamic properties of enterprises' time series and require further research.

The purpose of the study is to develop a stochastic trend model of sustainable development capable of covering the whole enterprise's life cycle. To achieve this goal, revenue is described by a stochastic process where drift and volatility are influenced by competition and inflation. The model is intended for practical application in ESG transition planning.

Theory

Due to economic uncertainty, revenue S_t at time t has a random value. To model this variable, we apply geometric Brownian motion whose cross-section complies with the logarithmically normal law:

$$dS_t = g_t S_t dt + \sigma_t S_t dW_t, \quad (1)$$

where g_t and σ_t are the drift and volatility parameters; W_t – Wiener process ($t \geq 0$). Parameters g_t and σ_t in equation (1) are time-dependent because the enterprise growth rate and the uncertainty level related to its operations change along with its life cycle stages. Usually, an enterprise demonstrates the fastest growth at the initial stages, and subsequently its development slows down. The sustainable development stage is the longest, and the last one with a positive growth rate. At this stage, programs aimed at decreasing the uncertainty level are implemented .

Drift

The drift parameter accounts for the rapidity of average revenue growth rate. In order to account for the influence of the external environment, we use the sustainable development trend model [4], where the rapidity of revenue growth rate – taking into account the changes caused by inflation and competition – is described by the following equation:

$$g_t = p_0 + \sum_{k=1}^{27} p_k e^{q_k t}, \quad (2)$$

with constants equal to:

$$p_0 = h_0 f_0 c_0 (1+l_0) + h_0 f_0 y_0 (1-\phi)(1+l_0) + h_0 n_0 \varepsilon (1+l_0) - n_0 \alpha (1-\phi) h_0 l_0,$$

$$p_1 = \left[h_1 f_0 c_0 + h_1 f_0 y_0 (1-\phi) + h_1 n_0 \varepsilon \right](1+l_0) - n_0 \alpha (1-\phi) h_1 l_0, \qquad q_1 = \delta,$$

$$p_2 = h_0 f_0 c_1 (1+l_0), \qquad q_2 = \gamma, \qquad p_3 = h_0 f_0 y_1 (1-\phi)(1+l_0), \qquad q_3 = \eta,$$

$$p_4 = h_0 n_1 \left[\varepsilon (1+l_0) - \alpha (1-\phi) l_0 \right], \qquad q_4 = \pi, \qquad p_5 = h_0 f_1 (1+l_0)\left[c_0 + y_0 (1-\phi) \right], \qquad q_5 = \xi,$$

$$p_6 = h_0 l_1 \left[f_0 c_0 + f_0 y_0 (1-\phi) + n_0 \varepsilon - n_0 \alpha (1-\phi) \right], \quad q_6 = \lambda,$$

$$p_7 = h_1 f_0 c_1 (1+l_0), \quad q_7 = \gamma + \delta, \quad p_8 = h_0 f_0 c_1 l_1, \quad q_8 = \gamma + \lambda,$$

$$p_9 = h_1 l_1 \left[f_0 c_0 + f_0 y_0 (1-\phi) + n_0 \varepsilon - n_0 \alpha (1-\phi) \right], \quad q_9 = \lambda + \delta,$$

$$p_{10} = h_0 f_0 y_1 (1-\phi) l_1, \quad q_{10} = \eta + \lambda, \quad p_{11} = h_0 n_1 l_1 \varepsilon - n_1 \alpha (1-\phi) h_0 l_1, \quad q_{11} = \pi + \lambda,$$

$$p_{12} = h_0 f_1 c_1 (1+l_0), \quad q_{12} = \gamma + \xi, \quad p_{13} = h_1 f_1 (1+l_0) \left[c_0 + y_0 (1-\phi) \right], \quad q_{13} = \xi + \delta, \quad (3)$$

$$p_{14} = h_0 f_1 y_1 (1-\phi)(1+l_0), \quad q_{14} = \eta + \xi, \quad p_{15} = h_0 f_1 l_1 \left[c_0 + y_0 (1-\phi) \right], \quad q_{15} = \xi + \lambda,$$

$$p_{16} = h_1 f_0 y_1 (1-\phi)(1+l_0), \quad q_{16} = \eta + \delta, \quad p_{17} = h_1 n_1 \varepsilon (1+l_0) - n_1 \alpha (1-\phi) h_1 l_0, \quad q_{17} = \pi + \delta,$$

$$p_{18} = h_1 f_0 c_1 l_1, \quad q_{18} = \gamma + \lambda + \delta, \quad p_{19} = h_1 f_1 c_1 (1+l_0), \quad q_{19} = \gamma + \xi + \delta,$$

$$p_{20} = h_1 f_1 l_1 \left[c_0 + y_0 (1-\phi) \right], \quad q_{20} = \xi + \lambda + \delta, \quad p_{21} = h_0 f_1 y_1 (1-\phi) l_1, \quad q_{21} = \eta + \xi + \lambda,$$

$$p_{22} = h_0 f_1 c_1 l_1, \quad q_{22} = \gamma + \xi + \lambda, \quad p_{23} = h_1 n_1 \varepsilon l_1 - n_1 \alpha (1-\phi) h_1 l_1, \quad q_{23} = \pi + \lambda + \delta,$$

$$p_{24} = h_1 f_1 y_1 (1-\phi)(1+l_0), \quad q_{24} = \eta + \xi + \delta, \quad p_{25} = h_1 f_0 y_1 (1-\phi) l_1, \quad q_{25} = \eta + \lambda + \delta,$$

$$p_{26} = h_1 f_1 c_1 l_1, \quad q_{26} = \gamma + \xi + \lambda + \delta, \quad p_{27} = h_1 f_1 y_1 (1-\phi) l_1, \quad q_{27} = \eta + \xi + \lambda + \delta,$$

where ϕ – profit tax rate; ε – the share of assets subject to additional evaluation due to price inflation, which are financed from equity and debt capital; α – the share of debt with free floating interest rate.

Equation (2) was obtained by introducing trends of financial ratios into the sustainable development inflation model [8; 9], including: investment b, asset turnover (S/A), return on sales m, financial leverage (D/E), the spread between the inflation rates of product and manufacturing resource prices z and the rate of inflation of manufacturing resource prices j, which reveal a change in statistical expectations of ratios over time:

$$E_t(b) = h_0 + h_1 e^{\delta t}, \quad E_t\left(\frac{S}{A}\right) = f_0 + f_1 e^{\xi t},$$

$$E_t(m) = c_0 + c_1 e^{\gamma t}, \quad E_t\left(\frac{D}{E}\right) = l_0 + l_1 e^{\lambda t}, \quad (4)$$

$$E_t(z) = y_0 + y_1 e^{\eta t}, \quad E_t(j) = n_0 + n_1 e^{\pi t},$$

where $h_0, f_0, c_0, l_0, y_0, n_0$ – final values responsible for extreme values of financial ratios when $t \to \infty$; $h_1, f_1, c_1, l_1, y_1, n_1$ – deviations from final values at time $t = 0$; δ, ξ, γ, λ, η, π – rates of deviation increment.

Since models [8; 9] provided the basis for equation (2), here, as in those models:

economy-wide inflation determines changes in manufacturing resource prices of an enterprise and the nominal interest rate on borrowed funds, and is added to the real rate according to the Fisher effect;

the investment ratio takes into consideration the amount of invested funds, as well as additional capital related to the increases in the value of an enterprise's assets, which is a result of an inflation-related increase in their nominal value.

Volatility

The volatility parameter controls the random change in the analyzed indicator. We use an exponential function to describe its time dependence:

$$\sigma_t = \sigma_0 e^{q_{28} t}, \quad (5)$$

where q_{28} – the rapidity of revenue volatility growth rate. According to (5), the direction of the volatility trend depends on the sign of q_{28}. If this constant is below zero, uncertainty decreases over time, if the constant equals zero – it remains constant, if the constant takes on a positive value – it increases. In practice, the rapidity of volatility growth rate may be calculated by comparing the volatility of several parts of a time series of the revenue growth rate logarithm.

Model

By applying (2) and (5) in (1), we obtain a stochastic differential equation of revenue:

$$dS_t = \left(p_0 + \sum_{k=1}^{27} p_k e^{q_k t} \right) S_t dt + \sigma_0 e^{q_{28} t} S_t dW_t. \quad (6)$$

After integrating it (see Appendix 1), we have the following stochastic model of the revenue growth rate logarithm for time points t and $t+T$:

$$\ln\left(\frac{S_{t+T}}{S_t}\right) = p_0 T + \sum_{k=1}^{27} \frac{p_k}{q_k} \left[e^{q_k (t+T)} - e^{q_k t} \right] - \frac{\sigma_{T,t}^2}{2} + \int_t^{t+T} \sigma_0 e^{q_{28} \theta} dW_\theta, \quad (7)$$

where $\sigma_{T,t} = \sigma \left[\ln\left(\frac{S_{t+T}}{S_t}\right) \right]$ – standard deviation of the

revenue growth rate, which equals:

$$\sigma_{T,t} = \sigma_0 \left(\frac{e^{2q_{28}(t+T)} - e^{2q_{28}t}}{2q_{28}} \right)^{0,5} . \quad (8)$$

Since financial ratios' trends allow to account for changes in corporate operating performance on a long-term horizon, model (7) covers the entire life cycle of the enterprise. The final values of trends produce the most significant influence in the revenue growth trajectory. It may be typical, logistic, exponential or ending in the decline stage [4]. If the growth rate of financial ratios, including volatility, equals zero, then after integrating (6), we obtain geometric Brownian motion that describes growth in an environment without external influence.

Data

The primary information source was the SKRIN database. We selected companies with non-zero reporting for 1998–2018 out of the enterprises with the largest revenue as of 1998. Subsequent analysis was differentiated by industry according to the Russian National Classifier of Types of Economic Activity (OKVED) (Table 1). Using the criterion offered in paper [10], we checked time series for structural changes. In spite of the 2008 economic crisis, market fluctuations, and technological innovations, no structural changes were detected in the overwhelming majority of enterprises. To analyze the dynamics of uncertainty, we verified statistical hypotheses about the variances of the first σ_1^2 and second σ_2^2 halves of the time series of the revenue growth rate logarithm and evaluated the volatility growth rate q_{28}. The reason for choosing this method was the limited span of the enterprises' time series, which renders the use of more complex calculations statistically unjustified. Besides, it should be noted that this method is of limited accuracy given the expected nonlinearity of the analyzed indicator. Variances were compared at the significance level of α = 0.05. The speed q_{28} was calculated using equation (8), assuming that variances σ_1^2 and σ_2^2 are in the middle of the halves of the time series. The distribution density of the volatility growth rate is demonstrated using enterprises engaged in the extraction of commercial minerals as an example (Figure 1). The presented data reveals that at the industry level, the tendency towards decreasing volatility prevails, while at the enterprise level, the model with constant volatility is more relevant. There may be a discrepancy present because the analyzed period is not sufficiently long, and q_{28} is too low for a statistically significant change in uncertainty to be found for all enterprises. The macroeconomic uncertainty index also indicates a slow rate of uncertainty decline (see Appendix 2). Thus, empirical analysis fails to provide an unambiguous answer concerning the direction of revenue volatility over a long-term horizon. Consequently, the issue of its exponential decrease at the enterprise level remains unsolved.

Statistical Modelling

We are going to consider the results of statistical modelling of the revenue growth rate logarithm using equation (7) (Figure 2). The dashed and solid lines show the results of calculations when $\sigma_0 = 0$. The enterprise's drift parameter is calculated on the basis of the average values of the financial ratios for JSC Kuzbasskaya Toplivnaya Company for 2001–2021. Random trajectories were constructed using truly random numbers from random.org. The rapidity of the volatility growth rate $q_{28} = -0.044$ corresponds to the average value for enterprises engaged in extraction of commercial minerals. Over time, the logarithm of the revenue growth rate gravitates towards to the level of p_0 (see Figure 2), which is indicative of the marginal growth rate. A decrease in the uncertainty level causes a degeneration of the stochastic component.

Table 1. Inconstancy of the uncertainty level

Industry	Sample size	Presence of structural changes	Number of enterprises with a confirmed hypothesis		Mean value q_{28}
			$\sigma_1^2 > \sigma_2^2$	$\sigma_1^2 < \sigma_2^2$	
Extraction of commercial minerals	68	5	13	0	-0.044
Commercial manufacturing	356	5	34	1	-0.037
Supply of electric power, energy, gas and steam; air conditioning	32	2	12	1	-0.065
Wholesale and retail; vehicle and motorbike repair	107	4	17	1	-0.056
Transportation and storage	58	12	9	0	-0.057
For all enterprises	621(100%)	28(4.5%)	85(14%)	3(0.5%)	-0.045

Figure 1. Density of the distribution of the revenue volatility growth rate

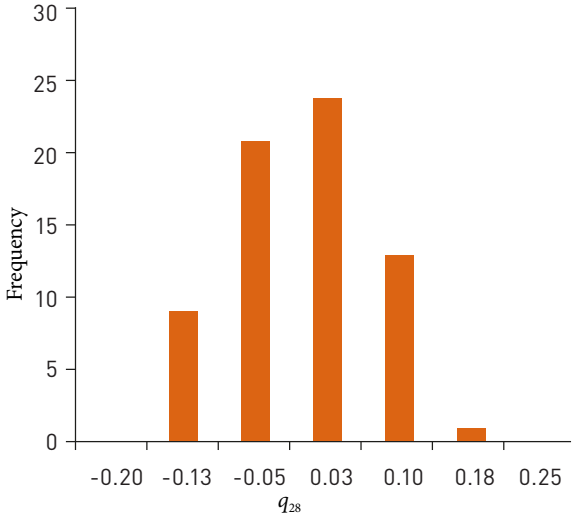
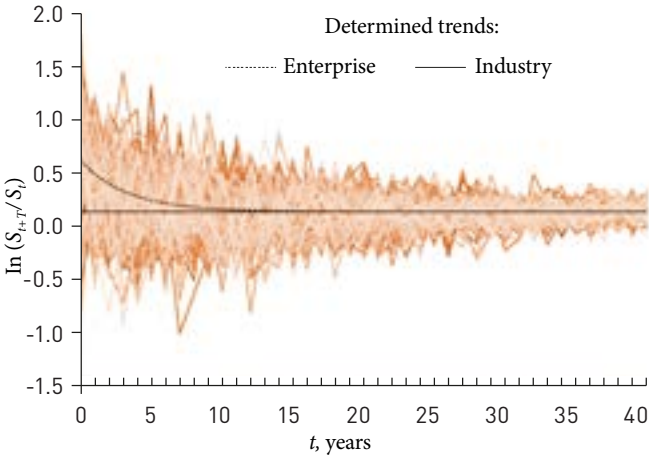


Figure 2. Logarithm of the revenue growth rate



Discussion

Hyper-long-term Nature of ESG Transformation

The ESG approach to operating a business has become the standard for enterprises seeking sustainable development [11]. To achieve actual changes in the environmental, social, and governance (ESG) spheres, it is necessary to apply ESG principles for a long time and go beyond strategic planning since there is a delayed effect of investment in sustainable growth. Model (7) meets these requirements and allows to model growth at a time horizon comparable with the length of the enterprise's life cycle. At the same time, it models sustainable growth, which is the key goal of ESG transformation.

Typical Enterprise and Proactive Planning

With different final trend values (4), the growth trajectory describes natural, typical, logistic growth or ends in a period of decline. Given that ESG programs are focused on sustainable development, the most suitable conditions for their implementation are offered in a typical development scenario aimed at achieving a stable growth stage. The financial indicators of a typical enterprise tend towards the levels established by industry medians [12–14]. The emergence of clear financial benchmarks limit the management's attempts to over-indulge in current profits at the expense of long-term development. There emerges an opportunity for proactive planning [15, p. 84]. It allows the enterprise not merely to respond to changes but to predict the trajectory of its development in advance, thus creating an ESG agenda and the environment for its implementation.

From Typical Uncertainty to Dynamic Efficiency

Model (7) allows for decreasing, sideways and growing trends of uncertainty. If revenue uncertainty is typical, then, similarly to other financial ratios of a typical enterprise, it demonstrates a negative rapidity of growth rate. Thereby, we obtain the dependence with $t \to \infty$ instead of (7):

$$S_t = S_0 e^{p_0 t}, \qquad (9)$$

where p_0 accounts for the rapidity of the revenue growth rate at the deterministic growth stage. As long as there is no uncertainty, p_0 corresponds to risk-free return. The rapidity of an enterprise's equity growth rate takes on the same value because its financial ratios remain unchanged. According to the intersecting generations model, if the capital growth rate and the risk-free return are equal, it is possible to avoid overaccumulation of capital, achieving the dynamic efficiency of stochastic economy with public debt [5]. At the enterprise level, this corresponds to a typical growth scenario, which allows to achieve a balance between current profit and long-term ESG objectives.

Factors of Uncertainty Decrease

ESG programs are not among "quick" volatility reduction tools, but as the effects from reducing regulatory, reputational and operational risks accumulate, they gradually reduce volatility:

- implementation of environment protection technologies (E) guards against regulatory and price risks. Revenue fluctuations related to a decline in production caused by accidents and administrative prohibitions decrease. Transition to renewable power sources guards against the volatility of fossil fuel prices;
- responsible social policy (S) drives consumer loyalty. Such enterprises have more stable demand even during financial crises. The risks of conflicts with local communities, strikes and consumer boycotts that may bring down sales disappear;
- improvement of corporate governance (G) mitigates corruption risks and reduces the potential for financial fraud, which causes reputational damage. This increases the number of reliable contract partners who maintain continuous renewal of production facilities and stable sales.

Conclusion

In spite of a general consensus concerning the prospects of the ESG economy, the issues of enterprises' transition to the sustainable development track have been understudied. The existing studies focus on the analysis of the consequences caused by introducing economic incentives and disciplinary measures that encourage ESG implementation, while the issues related to adapting corporate planning to new requirements remain unsolved. Such a one-sided approach makes it difficult to practically implement ESG programs. Hyper-long-term planning tools, including the stochastic trend model of sustainable growth, point towards a solution. Empirical data is indicative of two volatility trends that correspond to the constant and gradually decreasing levels of revenue uncertainty. The final conclusion about the prevailing direction of changes may be made after a study of time series exceeding twenty years. The offered model supports both versions and indicates that there is a connection between the latter one and the typical growth scenario. When this scenario is implemented, revenue growth rate gravitates towards the risk-free rate, thus fostering the economy's movement towards dynamic efficiency. When the latter is achieved, there is no need in non-market mechanisms for stimulating ESG programs.

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Appendix 1

Integration of a Stochastic Differential Equation of Sustainable Growth

We are going to solve the stochastic differential equation for steadily growing revenue:

$$dS_t = \left(p_0 + \sum_{k=1}^{27} p_k e^{q_k t} \right) S_t dt + \sigma_0 e^{q_{28} t} S_t dW_t, \quad (10)$$

where S_t – stochastic process; p_0, p_k, q_k, σ_0 and q_{28} – constants;
t – time $(t \quad 0)$; W_t – Wiener process.

We use the Ito formula for functions $F(S_t, t) = \ln S_t$, so that:

$$dF(S_t, t) = \varphi(t) dt + \sigma_0 e^{q_{28} t} dW_t, \quad (11)$$

where

$$\varphi_t = \frac{\partial F(S_t, t)}{\partial t} + \left(p_0 + \sum_{k=1}^{27} p_k e^{q_k t} \right) S_t \frac{\partial F(S_t, t)}{\partial S_t} + \frac{\left(\sigma_0 e^{q_{28} t} S_t \right)^2}{2} \frac{\partial^2 F(S_t, t)}{\partial S_t^2} = p_0 + \sum_{k=1}^{27} p_k e^{q_k t} - 0,5 \sigma_0^2 e^{2 q_{28} t}. \quad (12)$$

The solution of the stochastic differential equation (11) is described by the following process:

$$F(S_t, t) = F(S_0, 0) + \int_0^t \varphi(\theta) d\theta + \int_0^t \sigma_0 e^{q_{28} \theta} dW_\theta, \quad (13)$$

where S_0 – value of the stochastic process at the initial time point.

We get the first integral on the right side of the equation (13):

$$\int_0^t \varphi(\theta) d\theta = \int_0^t p_0 d\theta + \int_0^t p_1 e^{q_1 \theta} d\theta + \ldots + \int_0^t p_{27} e^{q_{27} \theta} d\theta - \int_0^t 0,5 \sigma_0^2 e^{2 q_{28} \theta} d\theta =$$
$$= p_0 t + \frac{p_1}{q_1} \left(e^{q_1 t} - 1 \right) + \ldots + \frac{p_{27}}{q_{27}} \left(e^{q_{27} t} - 1 \right) - \frac{\sigma_0^2}{4 q_{28}} \left(e^{2 q_{28} t} - 1 \right). \quad (14)$$

Since $F(S_t, t) = \ln S_t$ according to (13) we have:

$$\ln \left(\frac{S_t}{S_0} \right) = p_0 t + \sum_{k=1}^{27} \frac{p_k}{q_k} \left(e^{q_k t} - 1 \right) - \frac{\sigma_0^2}{4 q_{28}} \left(e^{2 q_{28} t} - 1 \right) + \int_0^t \sigma_0 e^{q_{28} \theta} dW_\theta. \quad (15)$$

With $q_{28} \neq 0$ the standard deviation of process (15) equals

$$\sigma_t = \sigma \left[\ln \left(\frac{S_t}{S_0} \right) \right] = \left\{ \int_0^t \left[\sigma_0 e^{q_{28} \theta} \right]^2 d\theta \right\}^{0,5} = \left[\frac{\sigma_0^2}{2 q_{28}} \left(e^{2 q_{28} t} - 1 \right) \right]^{0,5}. \quad (16)$$

For revenue from (15) we obtain:

$$S_t = S_0 \exp \left[p_0 t + \sum_{k=1}^{27} \frac{p_k}{q_k} \left(e^{q_k t} - 1 \right) - \frac{\sigma_0^2}{4 q_{28}} \left(e^{2 q_{28} t} - 1 \right) + \int_0^t \sigma_0 e^{q_{28} \theta} dW_\theta \right]. \quad (17)$$

Random quantity (17) is log-normally distributed with statistical expectation equal to:

$$E(S_t) = S_0 \exp \left\{ E \left[\ln \left(\frac{S_t}{S_0} \right) \right] + 0,5 \sigma_t^2 \right\} = S_0 \exp \left\{ p_0 t + \sum_{k=1}^{27} \frac{p_k}{q_k} \left(e^{q_k t} - 1 \right) - \frac{\sigma_0^2}{4 q_{28}} \left(e^{2 q_{28} t} - 1 \right) + \frac{\sigma_0^2}{4 q_{28}} \left(e^{2 q_{28} t} - 1 \right) \right\} =$$
$$= S_0 \exp \left[p_0 t - \sum_{k=1}^{27} \frac{p_k}{q_k} \left(1 - e^{q_k t} \right) \right]. \quad (18)$$

If $q_{28} = 0$ the standard deviation is described by the following formula:

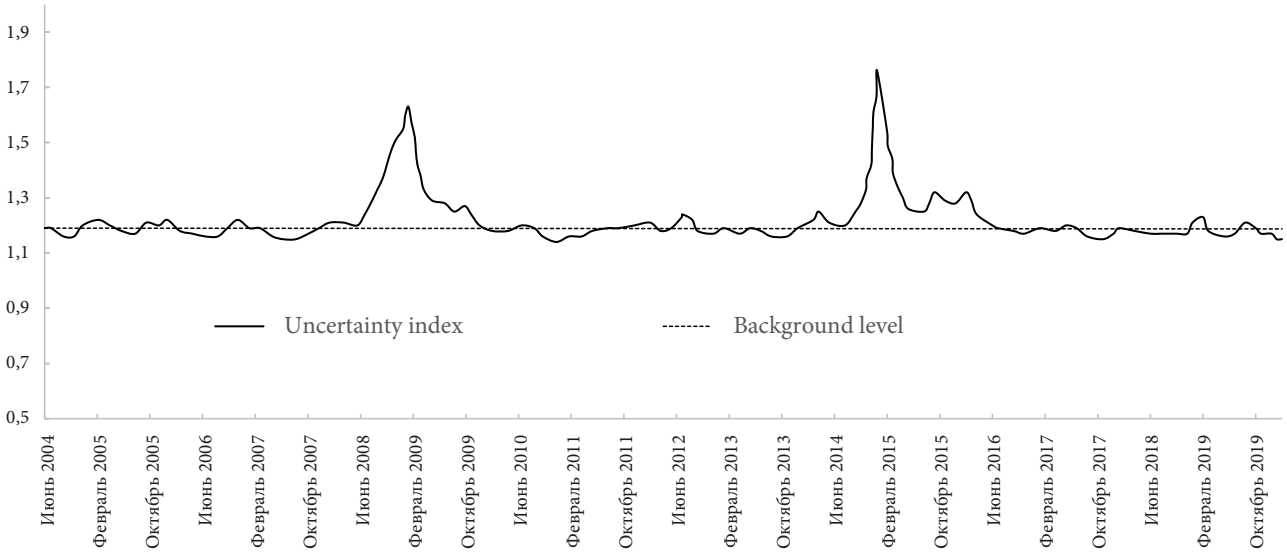
$$\sigma_t = \sigma \left[\ln \left(\frac{S_t}{S_0} \right) \right] = \left\{ \int_0^t \sigma_0^2 d\theta \right\}^{0,5} = \left[\sigma_0^2 t \right]^{0,5}. \quad (19)$$

Appendix 2

Uncertainty Index

The macroeconomic uncertainty index [16] equal to the weighted average of standard deviations of forecast errors over a 12-month horizon calculated on the basis of 39 macroeconomic indicators of the Russian economy has a two-component structure (Figure 3). The barely noticeable monotonic decrease in the indicator is interrupted by the outbursts that mark the periods of macroeconomic shocks. After approximating the background level with an exponential equation, the rapidity of the annual growth rate of the index turned out to be –0.00015.

Figure 3. Macroeconomic Uncertainty Index



Source: [16].

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Institutional Investors and Firm Performance: Evidence in the Oil and Gas Industry

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Abstract

This study investigates the effect of institutional investor ownership on the financial performance of firms in the oil and gas (O&G) industry. Using a panel of the 50 largest O&G companies worldwide from 2006 to 2020, we test the hypothesis that institutional investors enhance shareholder value and market capitalization through active monitoring and strengthened corporate governance. To address endogeneity and unobserved heterogeneity, we apply the System Generalized Method of Moments (GMM-Sys). Results demonstrate that institutional ownership has a positive and statistically significant effect on Tobin's Q, supporting the view that these investors can improve governance and align managerial decisions with long-term value creation. Dividend payouts also display a positive association with performance, consistent with agency theory. Carbon emissions are likewise positively related to valuation, indicating that carbon-intensive operations continue to yield substantial returns despite increasing environmental pressures. In contrast, firm size, leverage, and ESG scores do not emerge as significant determinants of performance, possibly reflecting industry-specific dynamics and measurement constraints. Overall, the findings highlight the dual reality in O&G valuation – where both investor-driven governance improvements and short-term drivers, such as dividends and fossil-fuel-based revenues, shape performance. The study contributes to the literature on institutional ownership with industry-specific evidence, suggesting that if institutional investors adopt long-term, sustainability-oriented strategies, they could play a pivotal role in guiding high-emission sectors through the transition toward lower-carbon business models. Future research should investigate institutional investor heterogeneity, investment horizons, and their role in advancing ESG practices and long-term value creation in the O&G industry.

Keywords: institutional investors, firm performance, oil and gas industry, GMM-sys

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Introduction

Oil has become an indispensable product for economic progress since it was consolidated as the main energy resource of modern economies. Society has established a dependence on this commodity due to its high energy density and extensive supply chain, ranging from exploration and extraction through processing to end use. In this context, companies with significant financial scale were created and have ranked among the largest companies in the world for decades. However, the energy paradigm shift to renewable sources is imposing a relevant redirection on the strategies of these corporations, challenging their leadership [1; 2].

The oil and gas (O&G) industry has also been facing changes in its strategic decision-making process with the emergence of the financialization phenomenon. This process is characterized by the progressive interrelation between the productive and financial areas of non-financial companies, implying a new finance-dominated accumulation regime [3]. Lazonick and O'Sullivan [4] emphasized that this process reorients corporate management strategies with a focus on shareholders' interests, resulting in a shift from the "retain-and-reinvest" pattern to "downsize-and-distribute". The cornerstone of this transformation is the shareholder value maximization (SVM) perspective. This new dynamic tends to be validated by the financial market by the appreciation of the stock price, influencing the company's market value [5–7].

The impacts of financialization have scaled up significantly since the late 1970s, with the increasing presence of institutional investors in the ownership structure of non-financial companies. In general, an institutional investor is a financial intermediary that "manages and invests other people's money" [8]. Pension funds, mutual funds, investment funds, hedge funds, and insurance companies are examples of institutional investors. In addition to the increase in the number and diversity of these entities, the volume of assets managed by them has been growing. To illustrate, according to Bebchuk et al. [9], between 1950 and 2017, institutional ownership of US corporate equity increased from 6.1 to 65%, which means that "institutional investors now control a large majority of the shares of public companies and have a dominant impact on vote outcomes at those companies". In the early 2020s, the three largest investment managers in the world, known as the "Big Three" – BlackRock, Vanguard, and State Street – managed more than US$ 20 trillion in assets [10–12]. Considering the pivotal S&P 500 stock index, Fichtner et al. [13] pointed out that "the Big Three combined constitute the largest owner in 438 of the 500 most important American corporations, or roughly in 88 percent of all member firms".

Several studies have investigated the influence of institutional investors on the corporate strategies of non-financial companies [14–16]. Since these agents do not represent a homogenous group, their influence on company strategies varies widely, according to the "business model" of institutional investors [8; 14] and their monitoring efforts in the companies that they invest in. Despite the vast literature on this topic, no study has explored the influence of institutional investors on corporate finance strategies in the O&G industry using a dynamic panel data approach. This novelty allows us to contribute to the literature by providing empirical evidence on how institutional investors may influence financial performance in a strategic sector under pressure to adapt to a low-carbon economy.

In this context, the purpose of this study is to evaluate whether the participation of institutional investors in the ownership structure impacts the financial performance of O&G companies. The research question guiding this study is: Does institutional investor ownership improve the financial performance of O&G companies? The hypothesis is that, by monitoring the activities of these companies and establishing corporate governance guidelines, the participation of these investors enhances value generation and increases market capitalization.

This study provides a comprehensive analysis of how institutional investors have impacted the financial performance of O&G companies. Given the importance of the O&G industry in the world's economy, research that evaluates how the decision-making process in O&G corporations can be influenced is relevant. Findings can provide relevant points for discussion regarding the role of institutional investors in guiding companies' strategic decisions. This point is particularly relevant nowadays since this industry has reached its mature phase and needs to adapt to a new energy paradigm. Institutional investors have the potential to influence the transition to a low-carbon economy, reorienting companies' strategies.

Literature review

Due to the amount of resources under their management, institutional investors have the potential to impact the global financial dynamics [17–19]. With the consolidation of the shareholder value maximization principle as a standard of corporate governance [20] and their increasing participation in the ownership of non-financial companies, these entities have played a significant role in defining corporate strategies.

One of the key contributions of institutional investors is their ability to provide liquidity to the markets. By investing large amounts of capital, they increase the supply of financial resources, which can benefit companies that need funding for their projects [21; 22]. On the other hand, some authors argue that these agents exert 'myopic' pressures on corporate management to achieve short-term returns [15: 23; 24] undermining long-term strategies [12; 25].

Focusing on the impact of institutional investors on corporate performance, the studies present mixed evidence. For instance, Abedin et al. [26] found evidence using a sample of publicly traded companies in Bangladesh that these agents have a positive influence on Tobin's Q and the return on asset (ROA) of the companies. Daryaei and Fattahi [27] conducted a similar analysis, showing that Tobin's Q, ROA, and Return on Equity (ROE) increase with institutional ownership. Similar evidence is reported by Han and Xiao

[28], who found that private placements involving only institutional investors are significantly linked to improved long-term performance in Chinese A-share listed companies.

Bajo et al. [29] also contributed to this debate. The authors verified that the central and more active institutional investors enhance the value of US companies since their presence produces a certification effect on the firm receiving the investment. Further, using a sample of firms in 30 countries, Bena et al. [30] showed that foreign institutional investors foster long-term investment, increasing innovation, firm valuation, and internationalization of companies' operations. Additionally, Alghorbany et al. [31] demonstrated that institutional investors enhance the effectiveness of IT investments by reducing agency-related concerns, thereby improving corporate performance.

On the other hand, Charfeddine and Elmarzougui [32] investigated the influence of institutional investor shareholding on the performance of French companies and found a negative and significant relationship between institutional ownership and financial performance. Satt et al. [33] found similar results in the Moroccan market, showing that the negative effect lingers regardless of the characteristics of the institutional investor (government or private institutions). According to the authors, since the majority of these investors presented small shareholdings, they did not exert a close monitoring effort, presenting short-term trading interests, rather than a long-term-oriented view. Finally, Bazhair and Alshareef [34] observed no effect of institutional shareholding on financial performance among Saudi companies.

Recent studies have also investigated the relation between institutional investors, corporate environmental performance (CEP), and corporate financial performance (CFP). Nguyen et al. [35] found that long-term institutional investors help U.S. firms align corporate social responsibility (CSR) with shareholder value by reducing cash flow risk. Similarly, Miller et al. [36] showed that institutional investors strengthen the CEP-CFP link when they internalize the costs of poor environmental practices, adopt a stakeholder-oriented perspective, and prioritize long-term value creation. In particular, local socially responsible and dedicated funds play a key role in reducing risks and fostering innovation. Following this debate, Li et al. [37] demonstrated that foreign institutional ownership improves the positive relationship between CSR performance and firm value in Chinese firms, especially in non-state-owned enterprises and those with high customer awareness or foreign board members. Complementarily, Alkurdi et al. [38] found that institutional ownership is positively associated with higher sustainability disclosure, particularly among more profitable firms.

Overall, these studies suggest that institutional investors can positively influence financial outcomes by strengthening corporate governance, reducing agency costs, and supporting long-term strategies. Although findings vary across contexts, there is growing evidence that the type, orientation, and active engagement of institutional investors are critical for translating CSR and sustainability practices into financial gains and lower risks. Moreover, the long-term investment horizon typical of institutional investors allows firms to convert environmental and social initiatives, often costly in the short term, into long-term value through risk mitigation, operational efficiency, and innovation.

While most empirical studies have focused on non-financial firms within specific countries or regions, they often overlook the industry-specific dynamics that may influence corporate behavior. This study addresses this gap by examining the impact of institutional investors on firm performance within the O&G sector. Although recent research has explored the relationship between ESG adoption and financial performance in O&G companies [39–42], limited attention has been paid to the role of institutional investors in this context. This remains a critical oversight, given the strategic importance of the O&G sector in ongoing energy transition efforts and environmental policy discussions.

Methodology

Model

To evaluate the influence of institutional investors on financial performance in the O&G industry, we use a model that explores the relationship between market value (Tobins's Q) and institutional investors' participation in the ownership structure of O&G companies.

The variable of interest is the institutional investor shareholding. On the one hand, the greater the potential of the firm to generate value, the greater the incentives for the participation of these investors. On the other hand, due to the monitoring and the new management guidelines, this presence tends to enhance the market value of the companies [26; 43; 44]. That is, we have a reciprocal relationship between Tobin's Q and the presence of institutional investors in the ownership structure [32; 45; 46]. Thus, the hypothesis of strict exogeneity of the regressors is invalidated, which makes estimators with random effects or fixed effects inadequate.

The problem of the interdependent relationship between the variables, quite common in corporate finance [47], can be mitigated by using the Generalized Method of Moments (GMM), developed by Arellano and Bond [48]. The GMM focuses on estimating dynamic models, which include lagged values of the dependent variable and explanatory variables, supposedly not correlated with errors, as instrumental variables.[1] Equation (1) describes the estimated model:

$$TQ_{it} = \alpha TQ_{it-1} + \beta_0 + \beta_1^t x_{1it} + \beta_2^t x_{2it} + a_i + \mu_{it}. \quad (1)$$

[1] While the System GMM estimator is appropriate for addressing endogeneity and dynamic relationships, other methods, such as fixed effects or Dynamic Panel Threshold Regression, may also be suitable, depending on the assumptions regarding endogeneity and potential non-linearity.

Where *i* and *t* represent, respectively, the firm and the time (years). The dependent variable (TQ_{it}) is Tobin's Q, which is calculated by the ratio between the equity market value and the equity book of the company. The intercepts are represented by β_0, β_1^t, and β_2^t. The vector that constitutes the explanatory variables, x_{it}, is divided into two subvectors: endogenous or predetermined (x_{1it}) and exogenous (x_{2it}). Finally, $a_i + \mu_{it}$ represents, respectively, the random effects and the error term of the model, given that $\mathbb{E}\left[\mu_{it}\right] = \mathbb{E}\left[\alpha_i\right] = 0$.

In the model developed by Arellano and Bond [48], the variables are transformed into the first difference to correct the effects on the unobserved heterogeneity. Thus, the assumption of strict exogeneity can be more flexible, considering only a sequential exogeneity of the regressors. To this end, the hypothesis that the regressors are correlated with past values of the error term, but not with its present or future values, is accepted. This approach enables the use of past or future values of the regressed variables or of variables external to the model as instruments, provided that they meet the same assumptions [14; 47].

The procedure consists of calculating the differences of the variables in terms of their lagged values. Then, we can accommodate the hypothesis that endogenous regressors are correlated with past values of the error term, but not with their present or future values, configuring a sequential exogeneity of the regressors [14; 47; 49]. However, according to Arellano and Bover [50], the model described, estimated by the Generalized Method of Moments in Differences (GMM-Dif), although capable of conceiving asymptotically valid and consistent statistics, can generate inaccurate and biased results.

To deal with these issues, Blundell and Bond [51] developed an extension of the method, namely the Systemic Generalized Method of Moments (GMM-Sys), which is used in this research. In this approach, the estimators are combined in a system of regressions in differences with regressions in level, using the lags of the endogenous explanatory variables in differences as instruments. If the hypothesis of sequential exogeneity is validated, other moment conditions are imposed on the GMM-Sys, equations (2) and (3):

$$\mathbb{E}\left[\Delta y_{it-1}\left(a_i + \mu_{it}\right)\right] = 0; \quad (2)$$

$$\mathbb{E}\left[\Delta x_{1it-1}\left(a_i + \mu_{it}\right)\right] = 0. \quad (3)$$

Another assumption is also considered, Δx_{1it-1} and a_i are not correlated. This premise remains if the form of the correlation does not change over time. Therefore, the GMM-Sys takes advantage of the same momentary conditions as the GMM-Dif and adds others, increasing the efficiency and performance of the estimator [47; 52]. The GMM-Sys modeling occurs in two stages, which can generate underestimated standard errors. Thus, the study uses Windjmeijer's correction for finite samples, ensuring that the two-stage results are more efficient and the standard errors are not biased [14; 53].

Data and variables

Companies were selected based on the European Classification of Economic Activities (NACE Rev. 2), focusing on firms engaged in exploration, support services, refining, and equipment manufacturing within the oil and gas sector. From the initial range of firms listed in the Refinitiv Eikon database, we retained the 50 largest companies based on total sales revenue, which together accounted for approximately 83% of the sector's revenue[2] – Appendix A. To ensure consistency across the panel, firms with missing values for any of the model variables in all years were excluded. The final dataset covers the period from 2006 to 2020.

To capture the influence of institutional investors on financial performance, we considered Tobin's Q (*TQ*) as the dependent variable – equation (4). This variable has been widely used to evaluate the performance of companies in the financial markets [26; 32; 43–45; 54–56].

$$TQ_{it} = \frac{EMV_{it}}{EBV_{it}}, \quad (4)$$

Where TQ_{it} is the ratio between the equity market value (*EMV*) and equity book value (*EBV*) of the company *i* in year *t*. Tobin's Q was scaled by the book value of equity to ensure comparability across firms.

We also considered the following control variables: company size, financial leverage, dividends, carbon emission, and the presence of institutional investors in the ownership structure of O&G companies (Table 1). Next, we explain these control variables and their expected relationship between these variables and *TQ*:

- Average Sales (*Size*): the sales (in logarithm) were used as a proxy for size [57]. The O&G industry comprises companies with high revenue generation capacity and a high degree of maturity, which tends to influence asset pricing. Also, the larger the size of the company, the greater its visibility [54]. Therefore, the expected relationship between *TQ* and *Size* is positive.
- Debt (*Debt*): financial leverage was analyzed by the debt-to-equity ratio [44]. On one hand, an increase in financial leverage may signal a larger future cash flow, which can positively influence a firm's valuation.

[2] The sample was based on companies operating in both upstream and downstream segments of the O&G sector. Specifically, 26 integrated companies – engaged in production, transportation, and refining – were selected; 8 crude oil producers focused on exploration, drilling, production, and supply of crude oil; 14 companies specialized in refining and marketing petroleum products; and 2 suppliers of equipment and services to oil fields and offshore platforms. Regarding ownership structure, the sample includes 15 international oil companies and 35 national oil companies. Geographically, the sample was composed of firms originating from a wide range of regions, including 16 companies from the United States and Canada, 18 from Asia (Russia included), 13 from Europe, 2 from Latin America, and 1 from Oceania.

On the other hand, a higher debt-to-equity ratio can restrict future cash flow due to amortizations and interest payments in the next period [26; 32; 56; 58]. Thus, the level of leverage is lagged by one period and the expected relationship between this variable and Tobin's Q is undefined.

- Dividends (*Dividends*): the payout of the company is analyzed by the total dividends paid during the fiscal year relative to net income[3]. O&G companies have a history of high distribution of dividends [59]. The payment of dividends contributes to the reduction of agency costs and can improve firm performance [60; 61]. We expect a positive relationship between *Dividends* and *TQ*.
- Carbon emission (CO_2): this variable is calculated as the ratio between a company's total CO_2-equivalent emissions (in million tons) and its total assets. It includes both direct emissions from owned or controlled sources (e.g., combustion from plants, vehicles, and equipment) and indirect emissions from purchased energy (e.g., electricity), but excludes emissions from the broader value chain (e.g., suppliers and customers). To account for firm size and reduce scale-related bias, CO_2 emissions were normalized by total assets – a particularly relevant adjustment in the O&G industry, where carbon intensity varies substantially across firms. While environmental performance has become increasingly important for non-financial corporations, especially in carbon-intensive sectors, revenues in this industry remain closely tied to fossil fuel activities. As such, the relationship between CO_2 and *TQ* is undefined [56].
- Environmental, Social, and Governance (ESG): is defined as a binary variable that equals 1 if the company's ESG score – calculated by Thomson Reuters[4] – exceeds the average for the oil and gas industry, and 0 otherwise. This operationalization allows for the differentiation of firms within the same sector, capturing relative rather than absolute ESG performance. Several studies indicated that the higher the ESG performance, the higher the capability of the firm to attract investors [62–64]. The use of a dummy variable represents a simplified approach to capturing ESG performance. The expected relationship between *ESG* and *TQ* is positive.
- $QTobin_{t-1}$ (TQ_{t-1}): O&G companies are mature companies, with a good history of appreciation in the financial market. These characteristics lead to inertial behavior, or a temporal persistence regarding the value of these companies [47]. Consequently, the expected relationship between this variable and *TQ* is positive.
- Institutional Investors (*II*): this variable is obtained by the ratio between the number of voting shares (common shares – CS) held by institutional investors and the total number of common shares. The expected relationship is positive [26; 43].

We also considered dummies for years to isolate shocks that could impact the valuation of companies, such as changes in the oil price.

Table 1. Explanatory variables used in the model

Explanatory variable	Description	Definition	Expected signal
TQ_{t-1}	Financial Performance	Ratio between the equity market value and equity book value (lagged by one period)	(+)
Size	Size	Total sales, in logarithm.	(+)
Debt	Debt-to-Equity Ratio	Ratio between total debt (lagged by one period) and shareholders' equity.	(undefined)
Dividends	Dividends	Ratio between dividend distribution and net income, in logarithm.	(+)
CO_2	Environmental Performance	Ratio between carbon emissions (in millions of tons of CO_2 equivalent) and total assets.	(undefined)
ESG	Environmental, Social, and Governance	Dummy variable that takes 1 if the company's ESG score is above average in the O&G industry, and 0 otherwise.	(+)
II	Institutional Investors	Ratio between the number of common shares held by institutional investors and the total number of common shares.	(+)

[3] It does not include share buybacks. This decision ensure consistency, given that dividends and buybacks, which are reported separately in the database and represent distinct mechanisms of shareholder remuneration potentially associated with different firm strategies and valuation implications.

[4] The ESG score methodology, adopted by Thomson Reuters, comprises more than 400 individual measures, grouped into 10 categories, incorporating indicators related to environmental performance, workforce management, innovation capacity, shareholder relations, and other relevant dimensions [65].

Table 2. Descriptive statistics

Variable	Obs.	Average	Standard deviation	Minimum	Maximum
TQ	695	1.92	1.94	0.08	15.96
Size	726	24.29	1.33	18.43	26.89
Debt	720	59.65	57.16	0.00	700.76
Dividends	591	–0.98	1.00	–5.77	3.70
CO_2	502	0.04	0.03	0.00	0.23
ESG	750	0.45	0.50	0.00	1.00
II	747	22.93	20.46	0.00	83.71

Note: TQ = Tobin's Q; Size = natural logarithm of total sales; Debt = debt-to-equity ratio; Dividends = ratio between dividend distribution and net income, in logarithm; CO_2: the ratio between carbon emissions (in millions of tons of CO_2 equivalent) and total assets; ESG = dummy variable that takes 1 if the company's ESG score is above average in the O&G industry, and 0 otherwise; II = the ratio between the number of common shares held by institutional investors and the total number of common shares.

The variables TQ_{t-1} and *II* were treated as endogenous, whereas the other variables were considered exogenous. To deal with this issue, the estimators were adapted to instrumental variables. Using lags of the original regressors as instrumental variables contributes to minimizing dynamic endogeneity. This problem occurs due to the feedback effects of the response variable for the regressors, that is, shocks that affect the dependent variable and will possibly affect the independent variables in subsequent periods [47]. The variables "Carbon emission (CO_2)" and "Dummies for years" were also incorporated as instrumental variables. According to the literature, the participation of institutional investors tends to reduce the carbon emissions of companies [66]. Therefore, environmental performance is correlated with the endogenous variable.

Results

Table 2 presents the descriptive statistics of the variables. The mean Tobin's Q (*TQ*) was 1.92, with a minimum of 0.08 and a maximum of 15.96, indicating high dispersion among the O&G companies of the sample. The mean sales (*Size*), in logarithm, was 24.29. This value was expected since the sample is characterized by the presence of large companies. The average financial leverage was around 60%, whereas the mean ratio between dividends and net income (in logarithm) was –0.98.

In addition, for every US$ 1 billion in total assets, the set of companies emits, on average, 400,000 tons of CO_2. The maximum was recorded by Formosa Petrochemical in 2015, reaching 2.3 million tons of CO_2 equivalent for every billion dollars of total assets. The ESG dummy mean was 0.45 – considering 750 observations, 336 were above average.

The average participation of institutional investors in the ownership structure of the sample companies was 22.93%, ranging from zero to 86.71%. The literature shows that the shareholding control of institutional investors varies according to the selection of companies and the definition used for their classification. For example, focusing on the US market, Bebchuk and Hirst [67] estimated that, for S&P 500 companies, the "Big Three" (BlackRock, Vanguard, and State Street) "collectively held a median of 27.6% of votes cast at annual meetings" at the end of 2021. For Indian firms, Panda [68] verified institutional investor participation of 21%. In addition, Al-Sartawi and Sanad [69] and Musallam et al. [70] verified participation of around 50% among Bahraini and Indonesian companies, respectively.

Appendix B shows the set of descriptive statistics and the distribution of the variables by year. We note a decrease in the maximum point reached by companies in Tobin's Q and a higher average indebtedness during 2015 and 2016 when the international oil price dropped sharply. The data also shows an increasing participation of institutional investors (median), as verified by previous studies [9; 13]. In addition, the ESG dummy shows an inflection point between 2014 and 2015. Whereas, in 2006, only 12 companies were above the mean ESG score, in 2020, this number reached 31 companies that showed an improvement in ESG performance in this period.

Table 3 shows the correlation matrix between the variables. Contrary to expectations, we observe a negative and significant correlation between Tobin's Q and company size (*Size*). In addition, carbon emission (CO_2) registered a positive and significant correlation with financial performance. Whereas carbon emissions showed a negative and significant correlation with the ownership of these investors, the ESG metric showed a positive and significant correlation. These findings point out the importance of environmental performance and corporate governance for institutional investors. As indicated by previous studies,

Table 3. Correlation matrix

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(1) TQ	1.000						
(2) II	0.032	1.000					
	(0.393)						
(3) Size	−0.240*	0.087*	1.000				
	(0.000)	(0.019)					
(4) Debt	0.074	−0.086*	−0.040	1.000			
	(0.050)	(0.021)	(0.282)				
(5) Dividends	−0.026	−0.105*	0.080	0.043	1.000		
	(0.532)	(0.011)	(0.053)	(0.301)			
(6) CO_2	0.199*	−0.128*	0.011	0.000	0.031	1.000	
	(0.000)	(0.004)	(0.809)	(1.000)	(0.523)		
(7) ESG	−0.055	0.195*	0.323*	−0.015	0.238*	−0.146*	1.000
	(0.144)	(0.000)	(0.000)	(0.692)	(0.000)	(0.001)	

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

institutional investors are in the process of changing their portfolio allocation to reduce their exposure to carbon-intensive assets [71; 72], seeking to mobilize resources under the aegis of ESG. In 2021, BlackRock, a preeminent capital management corporation, stated that ESG has become a critical factor in company valuation [73].

Table 4 presents the results of the first and second stages of model estimation, showing the estimated coefficients, standard deviations (in parentheses), and significance level (represented by asterisks). For all coefficients, we used the correction of standard errors proposed by Windjmeier for finite samples, orthogonal deviations, and corrections for small samples.

The results indicate a robust fit of the model to the data. In the Hansen test of overidentifying restrictions, we do not reject the null hypothesis, which attests to the suitability of the instruments. The Arellano and Bond [48] autocorrelation tests found a first-order negative autocorrelation in the idiosyncratic errors of the first difference, but not of the second. Thus, the hypothesis that μ_{it} is not autocorrelated is corroborated.

The two-stage estimator is more efficient but biased. However, with Windmeijer's correction, the two-stage specification becomes asymptotically more efficient and unbiased [53]. Therefore, the interpretation of the model will focus on the results from the second stage.

The results indicate that Tobin's Q lag in a certain period is statistically significant and positively correlated with its current value, which confirms the hypothesis of the inertial behavior of the variables, in line with the theoretical assumption [47].

The analysis reveals that the dividend variable has a positive and statistically significant effect on financial performance, consistent with the empirical evidence reported by Bossman et al. [74] and Farrukh et al. [75]. This finding aligns with agency cost theory, which posits that dividend payments serve as a governance mechanism to mitigate conflicts of interest between managers and shareholders. As Easterbrook [76] notes, higher dividend payouts reduce the free cash flow under managerial discretion, compelling firms to raise external financing and thereby subjecting managerial decisions to greater investor scrutiny. Such monitoring fosters transparency, accountability, and alignment of managerial incentives with shareholder interests, while promoting disciplined investment and more efficient capital allocation – factors that collectively improve firm performance [76; 77].

The strength of this relationship may also reflect the maturity of many O&G companies, which often operate with stable cash flows and limited high-return reinvestment opportunities, making dividends a preferred means of returning value to shareholders. Regular dividend payments can also signal financial stability and management's confidence in future earnings, reinforcing investor trust and supporting firm valuation. In the O&G sector – characterized by high capital intensity, cyclical commodity prices, and sub-

stantial cash generation during upturns – dividends may be perceived both as a commitment to shareholder returns and as a hedge against market volatility, further strengthening their positive association with financial performance.

A positive relationship between carbon emissions and Tobin's Q is also observed. This outcome reflects the prevailing cash flow structure in O&G companies, which remains heavily reliant on carbon-intensive activities that continue to deliver strong market returns despite their environmental costs. During the 2010s, institutional investors maintained substantial positions in such assets, while O&G firms began repositioning themselves as broader energy providers, a strategy that helped sustain their market valuations during the ongoing energy transition [78; 79].

This positive association may reflect a short-term effect, whereby immediate cash flows from carbon-intensive operations continue to drive firm valuation during this transitional period [80]. However, as global pressure for carbon neutrality intensifies and green investments gain traction, O&G companies have increasingly diversified into renewables, biofuels, and electricity distribution, while expanding R&D efforts to align with evolving market expectations – even though ESG scores have not yet shown a significant impact on firm performance [81].

Institutional investors are also adapting, as they recognize the potential to align environmental sustainability with financial performance. As a result, they are gradually redirecting capital toward climate-aligned strategies and reshaping market perceptions around the valuation of carbon-intensive assets [81–83]. Supporting this trend, Machado et al. [79] found that firms with higher levels of environmental innovation increasingly attract institutional investments.

In addition, results indicate that institutional investors' presence in the ownership structure positively impacts the financial performance of O&G companies. These agents not only provide capital but also actively engage in monitoring and advising firms, encouraging the adoption of practices that enhance long-term value [35; 36]. This influence can be particularly relevant in industries characterized by capital intensity and exposure to commodity cycles, where investor pressure can drive firms toward operational efficiencies, lower litigation and crash risks, and sustainable innovation pathways [37; 44]. Moreover, institutional investors can act as certification mechanisms that signal firm quality to the market, enhancing valuation beyond direct monitoring effects [29].

Finally, size, debt, and ESG show no significant influence on financial performance. The absence of a size effect is likely due to the homogeneity of the sample, which comprises only the largest companies in the O&G industry, thereby limiting variation in this dimension. As for debt, although the coefficient is not statistically significant, the relatively high standard deviation suggests a polarized distribution: while some firms operate with little or no debt, others are highly leveraged. This divergence may neutralize the average effect, indicating that the impact of debt depends on firm-specific factors such as capital structure, risk tolerance, and financial strategy. With respect to the ESG variable, the lack of statistical significance may reflect both the characteristics of current practices in the O&G industry and limitations of the available data. While ESG performance has gained visibility among investors, many sustainability initiatives in this sector remain in their early

Table 4. GMM-Sys estimation results

	1st stage		2nd stage	
TQ_{t-1}	0.805	***	0.806	***
	(0.099)		–117	
Size	–0.111		0.035	
	(0.390)		(0.270)	
Debt	1.211	*	0.634	
	(0.715)		(0.552)	
Dividends	0.509	***	0.375	***
	(0.180)		(0.143)	
CO_2	3.240	**	2.850	*
	–1.582		–1.500	
ESG	–0.108		–0.058	
	(0.383)		(0.400)	
II	1.945	***	1.533	**
	(0.682)		–0.786	
Dummies of Year	YES		YES	
Number of obs.	394		394	
No. of groups	45		45	
No. of instruments	44		44	
AR(1)	–2.50		–2.12	
p-value	0.013		0.034	
AR(2)	–1.13		–0.99	
p-value	0.258		0.322	
Hansen	18.05		18.05	
p-value	0.755		0.755	

Notes: i) *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$; ii) The 'YES' indicates that year dummies were incorporated into the model (their coefficients were not presented due to a space constraint); iii) For the Hansen, AR (1), and AR (2) tests, we highlighted the statistics and just below the p-value.

stages, potentially delaying their impact on market valuation. In addition, the use of an industry-relative dummy simplifies ESG measurement and may not capture variations in specific environmental, social, or governance dimensions that could influence firm performance more directly – an analysis that would require a dedicated focus on this dimension.

Conclusions

Several studies have investigated the influence of institutional ownership on corporate strategies. While some emphasize the positive role of institutional investors in monitoring and improving firm value, other suggest these agents may exert short-term pressure on managerial decision-making. This study contributes to this debate by evaluating the impact of institutional investor ownership on firm performance in the O&G industry – one of the most strategic sectors of the global economy which is currently under financial and environmental pressure.

Based on a panel of the 50 largest O&G companies and using the GMM-Sys, our findings indicate that institutional ownership has a positive and significant influence on financial performance. These results are consistent with prior evidence that highlights the beneficial role institutional investors can play in enhancing governance and aligning corporate strategies with shareholder interests.

The results confirm the relevance of institutional investors in capital markets and, in particular, in the O&G sector. As major capital holders and significant shareholders, they can influence both governance practices and long-term strategies, including those related to the energy transition. This underscores the need for regulatory approaches that address not only corporate practices but also the incentives and monitoring capacity of these investors. In a sector facing substantial sustainability challenges, their engagement can accelerate the adoption of sustainable practices and support low-carbon transitions.

Our results reveal that carbon emissions and dividend payments continue to exert strong influence on firm performance, suggesting that short-term financial metrics remain central to valuation in the sector. This coexistence points to a transitional moment: while institutional investors appear to support value-enhancing strategies, firms still rely on carbon-intensive activities and short-term shareholder rewards, reflecting the ongoing tension between legacy business models and the imperative of long-term transformation.

These insights are particularly relevant for investors, executives, and policymakers seeking to understand the drivers of performance in carbon-intensive industries. They reinforce previous literature that suggests that institutional investors can play a positive role in improving corporate long-term performance and implies that these investors may serve as catalysts for change, with the potential to guide companies through the challenges of the energy transition – provided they adopt long-term, sustainability-oriented approaches.

Nonetheless, this study has limitations. A key constraint is the treatment of institutional investors as a homogeneous group, despite the diversity of their objectives, time horizons, and levels of engagement. This simplification may overlook important nuances in how different types of investors influence firm behavior. Future research should explore these dynamics by distinguishing between pressure-sensitive and pressure-resistant investors, as well as examining the role of investment tenure in shaping firm strategies.

In addition, further research should explore the interaction between institutional ownership, ESG performance, and financial outcomes, particularly in industries undergoing structural transformation. Future studies could also break down ESG performance into its individual pillars – Environmental, Social, and Governance – to generate deeper insights. Additionally, examining the role of long-term-oriented institutional investors in aligning environmental objectives with financial performance represents a promising avenue for research. These investors may contribute to risk reduction and foster innovation, supporting the alignment of sustainability goals with financial outcomes, an area of increasing relevance amid the global transition toward decarbonization.

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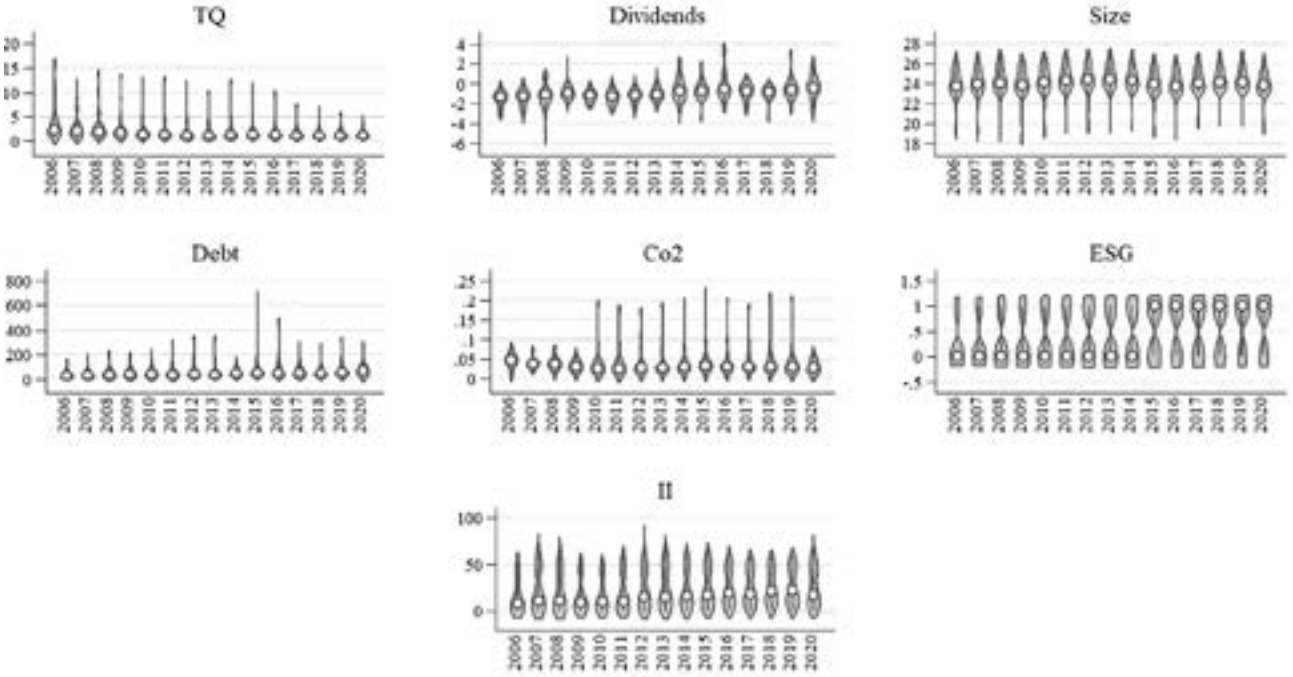
Appendix A. Selected companies of the study

1 AMPOL (CALTEX AUSTRALIA LIMITED)
2 BHARAT PETROLEUM CORPORATION LIMITED
3 BP PLC
4 CANADIAN NATURAL RESOURCES LIMITED
5 CENOVUS ENERGY INC.
6 CHEVRON CORPORATION
7 CHINA PETROLEUM & CHEMICAL CORPORATION
8 CNOOC LIMITED
9 CONOCOPHILLIPS
10 COSMO ENERGY HOLDINGS CO., LTD.
11 EMPRESA COLOMBIANA DE PETROLEOS - ECOPETROL S.A.
12 ENEOS (JXTG HOLDINGS, INC.)
13 ENI S.P.A.
14 EOG RESOURCES INC
15 EQUINOR ASA
16 ESSO SA
17 EXXON MOBIL CORP
18 FORMOSA PETROCHEMICAL CORPORATION
19 GALP ENERGIA, S.G.P.S., S.A.
20 HALLIBURTON CO
21 HINDUSTAN PETROLEUM CORPORATION LIMITED
22 HOLLYFRONTIER CORPORATION
23 HUSKY ENERGY INC.
24 IDEMITSU KOSAN CO., LTD.
25 IMPERIAL OIL LIMITED
26 KUNLUN ENERGY COMPANY LIMITED
27 MARATHON PETROLEUM CORPORATION
28 MOL MAGYAR OLAJ-ES GAZIPARI RT.
29 NATIONAL COMPANY KAZMUNAYGAZ JSC
30 NESTE OYJ
31 OCCIDENTAL PETROLEUM CORPORATION
32 OIL & NATURAL GAS CORPORATION LIMITED
33 OMV AKTIENGESELLSCHAFT
34 PBF ENERGY INC.
35 PETROCHINA COMPANY LIMITED
36 PETROBRAS
37 PHILLIPS 66
38 PJSC SURGUTNEFTEGAS
39 POLSKI KONCERN NAFTOWY ORLEN SA.
40 PTT PUBLIC COMPANY LIMITED
41 PUBLIC JOINT STOCK COMPANY GAZPROM NEFT
42 PUBLIC JOINT STOCK COMPANY OIL COMPANY LUKOIL
43 PUBLICHNOE AKTSIONERNOE OBSCHESTVO NEFTYANAYA KOMPANIYA ROSNEFT
44 REPSOL S.A.
45 ROYAL DUTCH SHELL PLC
46 SCHLUMBERGER N.V.
47 SUNCOR ENERGY INC.
48 TOTAL S.A.
49 TURKIYE PETROL RAFINERILERI A.S.
50 VALERO ENERGY CORP

Appendix B

Figure 1. Descriptive statistics and distribution graph of the variable



Note: Each graph contains the median (point) and the interquartile range (vertical bar in the center). TQ = Tobin's Q; Size = natural logarithm of total sales; Debit = debt to equity ratio; Dividends = ratio between dividend distribution and net income, in logarithm; CO_2: the ratio between carbon emissions (in millions of tons of CO_2 equivalent) and total assets; ESG = dummy variable that takes on a value of 1 if the company's ESG score is above average in the O&G industry, and 0 otherwise; II = the ratio between the number of common shares held by institutional investors and the total number of common shares.

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Digital Economy Empowers Carbon Emission Reduction: The Contribution of Digital Transformation to Carbon Neutrality for Chinese Enterprises

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Abstract

In recent years, with the rapid development of technology and the ICT field, enterprises and governments have been accelerating the digitalisation process. However, alongside technological advancements, climate change has become a matter of global concern. As the core participants in economic activities, enterprises play a crucial role in promoting economic development through digital transformation while reducing carbon emissions. Nevertheless, questions remain: Can digital transformation further assist enterprises in reducing carbon emissions, facilitating the realisation of China's "dual carbon" goals? And are there differences among different types of enterprises? This study employs the fixed effects model to conduct an in-depth analysis of these issues based on listed companies, state-owned enterprises, and large local private enterprises in China over the past decade. The research findings indicate that the digital transformation of enterprises can significantly reduce regional carbon emission intensity. Further study reveals that digital transformation promotes the low-carbon development of regions by driving technological innovation. Additionally, heterogeneity analysis shows that the impact of digital transformation is more significant in traditional high-energy enterprises. The innovation and contribution of this paper lie in exploring the effect of enterprise digital transformation on regional energy conservation and emission reduction from a digital perspective. It demonstrates that, in addition to the transition to clean energy, accelerating the digital transformation of enterprises provides another approach to achieving carbon neutrality. It also enriches academic research results in the fields of digital economy, energy conservation and emission reduction.

Keywords: digital economy, carbon emission intensity, corporate digitalization, technology, innovation, chinese evidence

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Introduction

In recent years, the digital economy has become the core driving force of global economic growth. According to statistics from the International Monetary Fund (IMF), the global digital economy accounted for more than 40% of the world's total economy in 2023[1]. According to World Bank data, the total global digital trade volume reached 7.13 trillion US dollars in 2023, representing 22.5% of total international trade [2]. With its advantages in digital technology innovation, the United States had a digital economy of 17.2 trillion US dollars in 2022, accounting for more than 65% of the GDP [3]. The European Union has also achieved remarkable results in digital economic governance, promoting the steady development of the digital economy [4].

China's digital economy has experienced rapid expansion, with its scale surpassing 50 trillion CNY in 2022, accounting for 41.5% of the GDP [5]. By 2023, this figure further increased to 53.9 trillion CNY, contributing 42.8% to the GDP and driving 66.45% of annual GDP growth [5]. Innovations in digital technologies – including big data, cloud computing, and artificial intelligence – have been instrumental in sustaining this growth trajectory [6].

While digital technologies – such as big data, cloud computing, and artificial intelligence – drive productivity and innovation, their environmental implications remain contested [7]. Prior research has extensively examined the economic benefits of digitalization [3–5], yet its role in mitigating climate change, particularly through corporate carbon emission reduction, lacks systematic evidence. This gap is critical to address, as digital transformation may either accelerate decarbonization through efficiency gains or exacerbate emissions via increased energy demand.

As the world's largest carbon emitter, China generated 11 billion metric tons (Mt) of CO_2 in 2022, representing 28.87% of global emissions [8], China has pledged ambitious "Dual Carbon" targets (peaking emissions by 2030 and achieving neutrality by 2060 [9]). While China's digital economy booms, existing studies predominantly analyse its macro-level impacts, overlooking how enterprise-level digitalization influences regional emission intensity – a key determinant of climate policy efficacy.

This study bridges three critical gaps in the literature. First, while prior work analyses digitalization's economic outcomes [3: 6], we provide granular evidence on its environmental effects by linking corporate digital transformation to regional carbon emission density. Second, existing metrics for digitalization (e.g., patent counts or broadband penetration) fail to capture firm-specific investments; we propose a novel financial-statement-based measure, quantifying digital assets (software, IT infrastructure, and intellectual property) to reflect true adoption depth. Third, we identify sectoral heterogeneities, revealing which industries benefit most from digitalization's decarbonization potential – a finding crucial for targeted policymaking.

Our findings offer timely insights for governments and firms balancing digital growth with sustainability. By demonstrating how enterprise digitalization can reduce emission intensity, this study informs China's "Dual Carbon" strategy while providing a replicable framework for other economies navigating the digital-climate nexus.

Literature Review

Research on the Relationship between Digital Economy and Carbon Emissions

The Carbon-Reducing Effect of the Digital Economy

Many scholars believe that the digital economy has an inhibitory effect on carbon emissions, mainly achieving carbon reduction through means such as optimizing resource allocation, promoting green technology innovation, and driving industrial structure upgrading.

The digital economy can enhance the accuracy and efficiency of resource allocation by virtue of technologies such as big data and cloud computing. For example, Kuang Y and Fan Y [10] found that the digital economy, by analysing massive amounts of data, can effectively reduce information asymmetry, enabling resources to flow and be distributed more rationally among various industries and enterprises. This avoids the idling and waste of resources and reduces carbon emissions caused by unreasonable production.

In terms of green technology innovation, the digital economy provides strong technological support and an innovative environment. Yumeng Sun [11] pointed out that digital technologies can accelerate the dissemination and sharing of knowledge, reduce innovation costs, and stimulate enterprises' enthusiasm for green technology research and development. The new business forms and models spawned by the digital economy also provide a broad market space for the application of green technologies, further promoting the latter's development and popularization.

Furthermore, the development of the digital economy can promote the optimization and upgrading of the industrial structure. The digital economy prompts the transformation of traditional industries towards digitalization and intelligence. The proportion of high energy-consuming and high-emission industries gradually decreases, while industries with low energy consumption and high added value are constantly emerging, improving energy efficiency and significantly lowering carbon emissions [12]. The digital economy can also reduce carbon emissions during the energy consumption process by improving energy efficiency.

Based on this, we propose our first hypothesis:

H1: Digital transformation exerts an inhibitory effect on the carbon emissions of enterprises, thereby significantly reducing the regional carbon emission intensity.

The Carbon-Increasing View of the Digital Economy

However, existing research has not yet reached a consensus on whether the digital economy can significantly limit carbon emissions, as well as its influencing mechanisms and effects. Some scholars hold other views, believing that the

digital economy can lead to an increase in carbon emissions during its development. Data centres, a key infrastructure of the digital economy, consume a large amount of energy during their operation. According to statistics, the electricity consumption of global data centres as a proportion of total global electricity consumption has been rising year after year, and the resulting carbon emissions cannot be ignored. Some research pointed out that the rapid development of the digital economy has led to a substantial increase in the demand for data storage, processing, and transmission, thus promoting the large-scale construction of data centres and resulting in an increase in carbon emissions [13–15].

The development of the digital economy also drives the development of related industries manufacturing servers, communication equipment, etc. The production processes of these devices consume a lot of energy and generate carbon emissions. At the initial stage of digital economy development in some regions, energy efficiency and environmental protection may be overlooked in favour of speed, leading to an increase in carbon emissions.

In recent years, research has increasingly shown that the relationship between the digital economy and carbon emissions is non-linear. Weihang Du and Xinnuo Liu [16] demonstrated empirically that, with the development of the digital economy, carbon emissions follow an inverted U-shaped curve. At the initial stage of digital economy development, the development of the digital economy may lead to an increase in carbon emissions due to limited technological levels and imperfect infrastructure. However, when digital economy development attains a certain stage, its functions of optimizing resource allocation, promoting green technology innovation, and upgrading the industrial structure gradually come into effect, achieving a reduction in carbon emissions.

Based on this, Zhang and Qi [17] introduced a spatial econometric model and found that the digital economy has a significant inverted U-shaped relationship with local carbon emissions and a U-shaped relationship of "first inhibition, then promotion" with carbon emissions in neighbouring regions. This indicates that the impact of the digital economy on carbon emissions not only exists locally but also affects neighbouring regions through spatial spillover effects.

Based on this, we propose our second hypothesis:

H2: The digital transformation of different types of enterprises contributes differently to the reduction of regional carbon emission intensity.

Exploring the Influence of the Digital Economy on Carbon Emissions

Industrial Structure Upgrading

The digital economy, with its strong technological advantages and innovation capabilities, plays a crucial role in promoting the transformation of the industrial structure towards low-carbonization. This is mainly reflected in two aspects: fostering emerging industries and transforming traditional industries [18].

With regard to the former aspect, the vigorous development of digital technologies has given rise to a series of highly promising emerging industries. A case in point is the big data industry. With the explosive growth of data volume, the demand for data storage, analysis, and application is increasing with each passing day, giving birth to a large number of enterprises engaged in data mining, data analysis, data visualization, and other processes. Through the in-depth analysis of massive data, these enterprises provide accurate decision-making support for various industries, optimize resource allocation, and thus reduce the energy consumption and carbon emissions of the entire society [19]. The cloud computing industry, by providing powerful computing power and storage resources, enables enterprises to avoid building large-scale local data centres, reducing the energy consumption and carbon emissions of hardware devices [20]. The artificial intelligence industry, through intelligent production and management, improves production efficiency, reduces production costs, and channels the development of industries into the green and low-carbon directions [21: 22]. Driven by digital technologies, the new energy vehicle industry has achieved breakthroughs in batteries, autonomous driving technologies, etc., accelerating the electrification of the automotive industry and significantly reducing carbon emissions in the transportation sector [23].

Regarding the transformation of traditional industries, the digital economy provides technological support for the digital and intelligent transformation of traditional industries [24]. Traditional manufacturing industries, by introducing technologies such as the Industrial Internet and the Internet of Things, have realized intelligent monitoring and management of the production process. Production equipment can collect data in real time and, through data analysis, optimize the production process, improve production efficiency, and reduce energy consumption [25: 26]. The digital economy has promoted the servitization of traditional industries. Manufacturing enterprises have shifted from simple product production to providing comprehensive solutions of products and services, increasing product-added value and reducing carbon emissions in the production process [27]. In the agricultural field, the application of digital technologies has led to the emergence of precision agriculture. By employing real-time monitoring and analysing data such as soil, climate, and crop growth, precise fertilization and irrigation are carried out, improving agricultural production efficiency and reducing agricultural non-point source pollution and energy consumption [28].

Driving Force of Technological Innovation

The digital economy provides comprehensive support for technological research, development, application, and diffusion, strongly promoting the reduction of carbon emissions [29].

At the research and development stage, the digital economy, through technologies such as big data and cloud

computing, provides abundant data resources and powerful computing capabilities for green technology research and development. Enterprises can use big data analysis to integrate and analyse information such as global green technology research results, market demands, and policy orientations, quickly discover breakthroughs in green technology research and development, avoid duplicate research, and improve research and development efficiency [30]. Cloud computing technology provides a powerful computing platform for complex green technology simulations and experiments, reducing research and development costs [31]. The digital economy also promotes the deepening of industry-university research cooperation. By building digital innovation platforms, it breaks down barriers between universities, research institutions, and enterprises, accelerating the flow and integration of green technology innovation factors [32: 33].

At the application stage, the digital economy promotes the wide application of green technologies in various industries [34]. Smart grid technology, through the intelligent management of the power system, realizes the efficient transmission and distribution of electricity, reducing power losses [35: 36]. Energy management systems use digital technologies to monitor and analyse the energy consumption of enterprises in real-time, helping enterprises formulate scientific energy management strategies and improve energy efficiency [37]. The sharing economy models spawned by the digital economy, such as shared mobility and shared office spaces, improve resource utilization efficiency, reducing resource waste and carbon emissions [38: 39].

At the diffusion stage, the network effects and platform advantages of the digital economy accelerate the spread of green technologies. Digital platforms provide convenient communication and trading channels for both the supply and the demand sides of green technologies, reducing the costs and risks of technology transfer. Enterprises can quickly obtain the required green technologies through the platform, accelerating the application and promotion of technologies [40: 41]. Digital channels such as social media and online forums also provide new ways for the promotion and popularization of green technologies, facilitating the dissemination and sharing of green technology knowledge [42: 43].

Other Influencing Factors

Investment plays a crucial role in the digital economy's impact on carbon emissions [44]. Venture capital investment in green technology innovation enterprises accelerates green technological research, development, and industrialization, contributing to the reduction of carbon emissions [45]. A large amount of capital flowing into the digital economy field has promoted the construction of digital infrastructure as well as research and development in the field of digital technologies. Investment in 5G network construction provides high-speed, stable network support for the development of the digital economy, facilitating the application of digital technologies in various industries, thus indirectly affecting carbon emissions [46].

The adjustment of the energy consumption structure is an important part of the digital economy's carbon reduction efforts [47]. The development of the digital economy has promoted the transformation of energy consumption towards clean energy. The application of smart grid technology has improved the absorption capacity of renewable energy, enabling clean energy such as solar and wind power to be more stably connected to the grid, reducing reliance on traditional fossil fuels, and thus lowering carbon emissions [48]. Digital technologies can also improve energy efficiency and reduce energy waste by optimizing the energy management system [49].

Government actions have an important guiding and regulating effect on the relationship between the digital economy and carbon emissions [50]. By implementing relevant industrial, tax, subsidy and other policies, the government promotes the development of the digital economy and the realization of carbon reduction goals. The government adopts industrial policies to encourage the development of the digital economy, guiding resources to converge in the digital economy field and promoting the innovation and application of digital technologies [51]. Tax-preferential policies for digital economy enterprises reduce the operating costs of enterprises and enhance their competitiveness [52]. By formulating strict environmental regulations and carbon emission standards, the government restricts the carbon emission behaviour of enterprises, prompting them to increase investment in green technological research, development, and application to achieve energy conservation and emission reduction [53]. The government can also guide market demand to incline towards green products and services through policies such as green procurement and promoting the green upgrading of industries [54: 55]. This leads to our third hypothesis.

H3: The digital economy drives enterprises to promote low-carbon development by enhancing green technology innovation.

Data and Methodology

Data Sources

This study utilizes panel data from listed companies across Chinese provinces over the past decade, including state-owned enterprises, central enterprises, and large private firms. The dataset primarily integrates China's digital economy and carbon emission statistics. For digital economy metrics, core data were extracted from the White Paper on China's Digital Economy Development (published by the China Academy of Information and Communications Technology, CAICT), which provides comprehensive statistics on digital economy scale, industrial structure, and growth trends. Supplementary indicators, such as value-added outputs and employment figures in digital-related sectors (e.g., information transmission, software, and IT services), were sourced from the China Statistical Yearbook [56].

Carbon emission data were obtained from the China Emission Accounts and Datasets (CEADs), a multi-scale car-

bon accounting database covering regional and industrial emissions [57]. Additionally, the Multi-resolution Emission Inventory for China (MEIC), developed by Tsinghua University, was employed to enhance spatial and temporal resolution [58].

To control for confounding factors, auxiliary variables – including industrial structure, GDP, population size, and energy consumption patterns – were compiled from the China Statistical Yearbook [56] and the International Energy Agency (IEA) database [59]. Missing values were addressed using linear interpolation.

Further supplementary data were derived from the China Statistical Yearbook on Science and Technology, provincial statistical yearbooks, the CSMAR database, and the EPS Data Platform [60: 61].

The final dataset consists of 6583 sample companies and converges to 330 sample observations. This paper uses Stata 18.0 software for empirical analysis.

Variable Description

Dependent Variable: The dependent variable is regional carbon emission intensity CO_{2s}, measured as total carbon emissions divided by regional GDP for province i in year t. Unlike studies focusing on aggregate emissions [62], this metric captures emission efficiency dynamics, aligning with IPCC guidelines for decoupling analysis. In the empirical analysis, the carbon emission intensity was logarithmically calculated to take into account the magnitude of the value.

Independent Variable: The independent variable is the corporate digitalization level Digt.

Currently, numerous studies assess digitalization levels by analysing the frequency of digital-related keywords in corporate annual reports, a method widely used to evaluate a company's degree of digitalization [63]. However, keyword frequency only reflects the management's attention to digitalization and does not represent the company's actual digital level. In contrast, evaluating digital assets is more practical, as it directly measures a company's investment in digitalization. Therefore, this study adopts the methodology of assessing a company's digitalization level by calculating the proportion of digital assets [64], such as software, cloud, servers, and big data, disclosed in annual financial statements. Specifically, the ratio of digital assets to intangible assets at year-end serves as a proxy indicator for measuring the degree of digitalization. Additionally, data from companies within the same province are aggregated to represent the digitalization level of that region.

Mediating Variable: Technological innovation $Tech_{it}$ is proxied by the annual count of granted patents per enterprise. Patent data were sourced from the China National Intellectual Property Administration (CNIPA) database, with utility models and design patents excluded to focus on substantive innovations.

Control Variable: It is necessary to add control variables to study whether enterprise digital transformation can drive green and low-carbon development. In this paper, we refer to related research studies to select the following control variables: the ratio of added value of tertiary industry to GDP (Pti), employment rate (Emp), urbanization level (Urb), foreign direct investment (FDI) and government fixed investment (Fix). Taking into account the magnitude of the values, we take the logarithm of FDI and Fix (Tables 1 and 2).

Table 1. Variable Definitions

Variable Type	Variable Name	Variable Symbol	Variable Description
Dependent Variable	Carbon emission intensity	CO_{2s}	Carbon emission per unit GDP was quantified and logarithmically transformed to mitigate skewed distribution.
Explanatory Variable	Digitalization level	Digt	Ratio of digital assets to total assets of sample companies.
Mediator Variable	Technical	Tech	The annual count of granted patents per enterprise.
Control Variable	Proportion of the tertiary industry	Pti	The proportion of the tertiary industry in the national economy.
	Employment rate	Emp	The proportion of the employed population in the working-age population.
	Urbanization rate	Urb	The proportion of the urban population in the total population.
	Foreign direct investment (FDI)	InFDI	Direct investment of foreign investors in domestic enterprises, logarithmically transformed to mitigate skewed distribution.
	Fixed investment	InFix	Investment used for the purchase of fixed assets, logarithmically transformed to mitigate skewed distribution.

Table 2. Descriptive Statistics

VARIABLES	Obs	Mean	Std. Dev.	Min	Max
$InCO_{2s}$	330	2.697	0.797	0.509	4.800
Digt	330	0.466	0.316	0.210	0.712
Tech	330	0.016	0.043	0.000	0.556
Pti	330	0.477	0.097	0.297	0.839
Emp	330	0.855	0.874	0.815	0.954
Urb	330	0.596	0.121	0.350	0.896
lnFDI	330	12.808	1.749	6.995	15.09
InFix	330	18.733	0.871	15.847	20.251

Model Construction

To explore the relationship between the digital economy and carbon emissions intensity, this study constructs a series of econometric models. The carbon emission intensity is greatly affected by specific and unobservable region individual characteristics [65]. This research employs a two-way fixed effects model regression. This model can effectively mitigate the influence of unobservable variables related to year and individual, decrease estimation biases, and improve the statistical reliability of the results [66].

The benchmark regression model is specified as:

$$InCO_{2sit} = a_0 + a_1 Digt_{it} + a_2 Control_{it} + \mu_t + a_i + \sigma_{it}. \quad (1)$$

To verify the role of technology innovation as an internal mechanism in the digital economy's empowerment of low-carbon development, this paper constructs the following mediation effect model:

$$Tech_{it} = \beta_0 + \beta_1 Digt_{it} + \beta_2 Control_{it} + \mu_t + a_i + \sigma_{it}; \quad (2)$$

$$InCO_{2sit} = \varphi_0 + \varphi_1 Digt_{it} + \varphi_2 Tech_{it} + \varphi_2 Control_{it} + \\ + \mu_t + a_i + \sigma_{it}. \quad (3)$$

where $InCO_{2sit}$ represents the carbon emissions intensity of region i in period t; Dig_{it} represents the digital economy indicator of entity i in period t; $Control_{it}$ represents a set of control variables for region i in period t; σ_{it} is the random error term; μ_t is the individual specific fixed effect; $_i$ is the time specific fixed effect; $Tech_{it}$ represents the technology innovation indicator of entity i in period t. Equations (2) and (3) are used to test whether technology innovation $Tech_{it}$ plays a mediating role in the relationship between the digital economy Dig_{it} and carbon emissions intensity $InCO2_{sit}$.

Empirical Analysis

Baseline Regression Analysis

To systematically examine the impact of enterprise digital transformation on regional low-carbon development, this study employs a fixed effects model methodology (Table 3). The empirical results reveal that in the baseline model without control variables (Column 1), the regression coefficient of the digital economy (Digt) is –0.0565 ($p < 0.01$), indicating a statistically significant negative inhibitory effect of enterprise digitalization on regional carbon emission intensity.

Table 3. Baseline Regression Results

	(1) $InCO_{2s}$	(2) $InCO_{2s}$
Digt	–0.0565***	–0.0329***
	(–5.47)	(–4.98)
Pti		–0.0401**
		(–2.45)
Emp		0.0531
		(1.13)
Urb		0.212***
		(2.82)
lnFDI		0.512***
		(2.77)
InFix		0.689***
		(4.76)
_cons	3.626***	2.146***
	(8.37)	(4.11)
Year FE	Yes	Yes
Firm FE	Yes	Yes
N	330	330
Adj. R^2	0.698	0.657

Note: The T statistic is in parentheses; *, **, and *** represent significance levels of 10%, 5%, and 1%, respectively.

Table 4. Robustness Test Results

	(1) Replace Variable	(2) Exclusion Test	(3) Random Effects	(4) Province & Year Joint Fixed Effects
	$LnAvgCO_{2s}$	$InCO_{2s}$	$InCO_{2s}$	$InCO_{2s}$
Digt	−0.0350***	−0.0298***	−0.0479***	−0.0311***
	(−4.87)	(−3.95)	(−5.21)	(−4.32)
Pti	−0.0381***	−0.0522**	−0.0478***	−0.0332**
	(−3.61)	(−2.41)	(−2.88)	(−2.39)
Emp	0.0631	0.0831*	0.0617	0.0511
	(1.67)	(1.78)	(1.51)	(1.01)
Urb	0.298***	0.317***	0.261***	0.201***
	(2.96)	(3.96)	(2.97)	(2.61)
lnFDI	0.673***	0.902***	0.549***	0.477***
	(3.85)	(5.31)	(3.11)	(2.61)
InFix	0.711***	0.982***	0.837***	0.621***
	(4.32)	(6.63)	(4.99)	(3.93)
_cons	3.37***	5.651***	2.763***	1.911***
	(5.57)	(7.68)	(4.78)	(4.11)
Year FE	Yes	Yes	No	Yes
Firm FE	Yes	Yes	No	Yes
Province*year	No	No	No	Yes
N	330	286	330	330
Adj. R^2	0.563	0.452	0.661	0.537

Note: The T statistic is in parentheses; *, **, and *** represent significance levels of 10%, 5%, and 1%, respectively.

In Column 2, which includes all the control variables, the regression coefficient of the digital economy (Digt) is −0.0329 ($p < 0.01$), indicating a statistically significant negative inhibitory effect of enterprise digitalization on regional carbon emission intensity. Notably, the proportion of the tertiary industry demonstrates a significant negative correlation with regional carbon emission intensity ($\beta = -0.0401$, $p < 0.05$), which aligns with industrial structure evolution theory. Compared to energy-intensive secondary industries, the tertiary industry – predominantly comprising service sectors – exhibits inherently low-carbon characteristics, further substantiating the carbon reduction benefits of industrial structural upgrading. Among other control variables, urbanization rate ($\beta = 0.212$), foreign direct investment ($\beta = 0.512$), and fixed asset investment ($\beta = 0.689$) all show significant positive correlations with carbon emission intensity ($p < 0.01$). This can be interpreted through an economic lens: foreign capital and government investments predominantly target high-energy-consumption sectors such as manufacturing and construction, while urbanization-driven population agglomeration systematically escalates the demand for transportation and energy infrastructure, thereby generating scale effects on carbon emissions. Additionally, the employment rate variable fails to achieve statistical significance ($p > 0.1$), suggesting that labour market dynamics may require further exploration within this analytical framework to elucidate their impact on carbon emissions.

This finding validates Hypothesis 1. The underlying mechanism may be attributed to digital technologies optimizing production processes, enhancing resource allocation efficiency, and effectively reducing energy consumption intensity while maintaining economic output, thereby achieving marginal diminishing effects on carbon emissions.

Robustness Test

To enhance the credibility of the research conclusions, this paper conducts robustness tests on the benchmark regression results through several different methods.

Table 5. Mechanism Test Results

	(1) Tech	(2) $InCO_{2s}$
Digt	0.0210***	−0.0291***
	(4.67)	(−3.88)
Tech		−1.527***
		(−5.28)
Pti	0.131	−0.0411***
	(1.51)	(−2.71)
Emp	0.096	0.0589
	(0.96)	(1.09)
Urb	0.216***	0.238***
	(2.11)	(2.97)
lnFDI	0.728***	0.509***
	(4.57)	(2.66)
InFix	0.523***	0.712***
	(3.37)	(4.33)
_cons	1.87***	2.550***
	(7.37)	(6.46)
Year FE	Yes	Yes
Individual FE	Yes	Yes
N	330	330
Adj. R^2	0.527	0.565

Note: The T statistic is in parentheses; *, **, and *** represent significance levels of 10%, 5%, and 1%, respectively.

Replacement of the Explained Variable: Drawing on the measurement method of Shao Shuai et al. (2019), this study replaces the explained variable with the natural logarithm of per-capita carbon emission intensity (LnAvgCO2s) and re-estimates the model. Column (1) of Table 4 shows that the regression coefficient of the digital economy variable is consistent with that of the benchmark regression in terms of direction and significance level, indicating that the core conclusion is not affected by the variable measurement method.

Sub-sample Exclusion Test: Considering the systematic differences in administrative levels, resource endowments, and digital infrastructure among municipalities directly under the central government, this study excludes the observation samples of four municipalities directly under the central government, namely Beijing, Tianjin, Shanghai, and Chongqing, and conducts re-regression. As shown in Column (2) of Table 4, the estimated coefficient of the digital economy variable still passes the significance level test, proving that the research conclusion has geographical universality.

Model Specification Adjustment: This study replaces the fixed-effects model with a random-effects model for a sensitivity test. In Column (3) of Table 4, the coefficient of the digital economy variable is still significantly negative. In Column (4) of Table 4, we employee the province* year joint fixed effects to show that the key findings remain robust, further strengthening the credibility of the conclusions.

Mechanism Analysis

Building on the theoretical framework, this study introduces technological innovation as a mediating variable to examine the mechanism through which the digital economy influences carbon emissions. A stepwise regression approach is employed to test whether the digital economy suppresses carbon emissions by incentivizing technological innovation.

Columns (1) and (2) in Table 5 reveal that the digital economy significantly promotes technological innovation. When introducing technological innovation into the baseline regression, the mediating variable exhibits a significant inhibitory effect on carbon emissions, while the negative correlation between the digital economy and carbon emissions persists. This confirms the partial mediation effect, indicating that the digital economy reduces carbon emissions by driving technological innovation. This finding validates Hypothesis 3.

These findings align with the theoretical proposition that digital technologies enhance data-driven R&D efficiency and accelerate the diffusion of low-carbon innovations, thereby establishing a "digital infrastructure–green innovation–emission reduction" causal chain.

Heterogeneity Analysis

To investigate the industry-specific heterogeneity of the impact of enterprise digital transformation on regional carbon emissions, this study categorizes sample firms into primary (agriculture), secondary (industry), and tertiary (services) sectors based on the Chinese Economic Industry Classification standard and conducts cross-industry comparisons using grouped regression models (Columns (2)–(3) in Table 6). Empirical results reveal significant sectoral disparities in the carbon mitigation effects of digital transformation (Digt). The regression coefficients for the secondary and tertiary sectors indicate that the inhibitory effect of digitalization on emissions is substantially stronger in the secondary sector. Notably, the coefficient for the primary sector fails to achieve statistical significance, which may be attributed to the low energy intensity and inadequate penetration of digital technologies in the agricultural sector.

The secondary sector, encompassing manufacturing, mining, and construction serves as the backbone of regional economies but exhibits high energy intensity. Its digital transformation enhances marginal emission reduction elasticity through intelligent production system restructuring (e.g., industrial IoT deployment) and clean technology substitution (e.g., AI-driven process optimization). These

Table 6. Heterogeneity Test Results

	(1) Primary Sector $InCO_{2s}$	(2) Secondary Sector $InCO_{2s}$	(3) Tertiary Sector $InCO_{2s}$
Digt	0.0210 (1.29)	−0.0302*** (−5.32)	−0.0298*** (−3.98)
Pti	−0.0123** (−2.43)	−0.0201*** (−3.89)	−0.0320** (−1.98)
Emp	0.0226 (1.32)	0.1026 (1.61)	0.1531 (1.83)
Urb	0.349* (1.87)	0.536*** (2.98)	0.322*** (3.31)
lnFDI	0.277 (1.53)	0.677*** (3.56)	0.378*** (2.99)
InFix	0.335** (2.35)	0.876*** (5.05)	0.323** (2.31)
Control	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Individual FE	Yes	Yes	Yes
N	33	146	151
Adj. R^2	0.601	0.662	0.677

Note: The T statistic is in parentheses; *, **, and *** represent significance levels of 10%, 5%, and 1%, respectively.

findings align with the "technology-biased emission reduction" theory proposed by Acemoglu et al. (2022). This finding validates Hypothesis 2.

Although the tertiary sector – including finance, logistics, and IT services – operates under a capital-light model, its decarbonization pathways predominantly rely on service-oriented digital.

Conclusions and Policy Implications

This study investigates the impact of corporate digital transformation on carbon emission reduction and carbon neutrality goals, utilizing a decade of data from listed companies, state-owned enterprises, central enterprises, and major local private enterprises across China. The findings reveal that digital transformation significantly reduces regional carbon emission intensity by fostering technological innovation, enhancing production efficiency, and improving energy utilization, thereby advancing low-carbon development.

Heterogeneity in Firm-Specific Effects: The carbon reduction effects of digital transformation exhibit substantial heterogeneity across enterprises, with a more pronounced impact on traditional high-energy-consuming industries. This underscores the pivotal role of digitalization in transitioning carbon-intensive sectors toward a low-carbon economy. For instance, digital technologies such as smart monitoring systems in heavy industries optimize production processes and reduce energy consumption, supporting Hypothesis 1. These results align with existing literature emphasizing the potential of digital economies to optimize resource allocation, drive green innovation, and upgrade industrial structures.

Mechanism of Technological Innovation: The study validates Hypothesis 2, demonstrating that technological innovation serves as a critical mediator in the relationship between digitalization and green development. Digital technologies provide robust data resources and computational capabilities during R&D phases, while digital platforms accelerate the diffusion of green technologies. For example, cloud computing facilitates complex simulations of sustainable technologies, highlighting the necessity of fostering an integrated ecosystem that synergizes digital innovation with green technological advancement.

Policy Relevance for High-Energy Industries: The heterogenous analysis corroborates Hypothesis 3, indicating that targeted policies to accelerate digital transformation in high-emission sectors – such as intelligent energy man-

agement systems in manufacturing – can yield effective decarbonization strategies. This insight is particularly critical for China's "Dual Carbon" goals, given the scale and spatial diversity of its industrial base.

Limitations and Future Research

While this study provides empirical evidence on the carbon mitigation potential of digital transformation, limitations exist. First, the reliance on regional and firm-level aggregated data may obscure micro-level dynamics. Future research should incorporate granular datasets, such as enterprise-specific digital investment portfolios and carbon accounting metrics. Second, the analysis focuses on static effects; dynamic models capturing long-term interactions between digitalization and emission trajectories are warranted. Lastly, external factors such as global supply chain shifts and international policy spillovers warrant deeper exploration to refine context-specific policy frameworks.

Policy Recommendations. Sector-Specific Incentives: Implement differentiated subsidies and tax incentives (e.g., accelerated depreciation for digital infrastructure in high-energy industries) to lower transition costs. Digital-Green Synergy: Establish innovation hubs integrating cloud computing, AI, and green tech R&D, supported by open-access government datasets for algorithm training • Regulatory Frameworks: Mandate real-time carbon emission monitoring via IoT-enabled digital systems and link corporate carbon performance to ESG ratings and financing eligibility. These measures aim to harness digital transformation as a strategic lever for achieving carbon neutrality, offering replicable insights for emerging economies pursuing sustainable industrial transitions.

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Building a Business Ecosystem: Deriving a Framework and Testing It with Case Studies

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Abstract

Ecosystem-based business models have received significant attention and praise in both business and research literature. Endeavours in building ecosystems sometimes prove successful, with firms transitioning to ecosystems enjoying valuation multiples significantly higher than their conventional peers. In practice, this entails firms expanding beyond their core offerings, such as a bank venturing into e-commerce. However, despite the evident interest in ecosystem-based business models, up to 85% of such ecosystems ultimately fail. Despite these notable failure rates, there has been limited discussion in research literature regarding the composition of businesses that yield reliable results within ecosystems. In this paper, we first propose a "Hook-Engage-Monetize (HEM)" framework for understanding ecosystem business composition. We apply this framework to nine case studies of successful and less successful ecosystems from nine different countries. Our analysis demonstrates the potential of HEM as a tool for selecting businesses for ecosystems and for guiding future quantitative financial research in this area.

Keywords: corporate performance, ecosystems, digital transformation

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Introduction

Improving performance through innovations stands as a primary objective for firms' management and boards of directors. Crucial tools in pursuit of this goal are digitalization [1] and business model innovation capable of providing digital-enabled performance improvement [2]. The joint effect of digitalization-based business model innovations is clearly represented by ecosystems. While its overarching importance has been underscored [3], there remains debate regarding the efficiency of its various components. Researchers have pointed out shortcomings, such as those found in AI [4] and blockchain [5], as well as Agile ways of working [6].

Regarding ecosystems, some researchers assert, "You either become a platform, or you will be killed by one" [7]. This sentiment is echoed in the business community, as evidenced by a survey conducted by BCG, where up to a quarter of managers anticipate that about 60% of industry revenue will be generated by ecosystems [8].

From a practical standpoint, adopting an ecosystem model typically involves diversifying into business lines that are quite distinct from a firm's core operations [9]. For example, a bank may venture into e-commerce, or a telecom operator may expand into the travel business [10]. The primary objectives of such expansions include broadening the customer base [11], monetizing existing customer relationships and services [12; 13], enhancing business resilience [14], or simply increasing the valuation multiple using the ecosystem trend [15].

However, achieving the desired results with ecosystems remains a challenge. In fact, many firms attempting to construct ecosystems find themselves significantly pivoting, or even closing or selling non-core businesses altogether. While numerous factors contribute to this, including corporate governance choices, one of the primary reasons is a business composition that fails to yield the desired outcome [16].

Surprisingly, the topic of ecosystem business composition has received limited attention in research literature, with scholars often focusing more on corporate governance [17] and on the technological aspects of ecosystem functioning [18]. In this paper, we aim to address this gap by offering a framework for understanding the benefits and pitfalls of ecosystem models derived from actual experience.

We propose a framework for selecting products and tools to build a business ecosystem, consisting of three components: **Hook** the customer, **Engage** the customer, and **Monetize** the customer relationship (HEM). We verify this framework using nine case studies of firms that have successfully or less successfully built ecosystems in Argentina (Mercado Libre), Kazakhstan (Kaspi), South Korea (Kakao), Malaysia (Grab), France (Orange), Japan (Rakuten), India (SBI), UAE (Mashreq), and Spain (BBVA). Success was measured by benchmarking valuation multiples of ecosystems vs focused peer firms.

The rest of this paper is organized as follows. First part 1 presents a review of the literature on ecosystems and business composition. In second part 2, we propose a framework for business line selection for building ecosystems. Third part outlines our approach to case studies and presents the empirical evidence. The results of case analysis are summarized in fourth part. Finally, we offer conclusions, discuss limitations, and outline the steps for further research.

Literature Overview

The research literature has shown an increasing interest in platform and ecosystem business models. For instance, there has been noted a sevenfold increase in the frequency of the keyword "ecosystem" in the title or abstract of top strategy journals over the five years [9]. However, there is still no universally accepted definition for these terms. Some authors, (e.g. [19]) distinguish between platforms and ecosystems, while others, (e.g. [20] do not. Researchers define platform businesses as companies that "leverage networked technologies to facilitate economic exchange, transfer information, and connect people" [17]. They emphasize that value is created for the platform owner by enabling interactions between value creators and value extractors. The fundamental feature of platforms lies in their ability to bring together dispersed agents to generate value. Well-known examples include Uber and Airbnb, which consolidate the services of drivers and rental properties, respectively. Other researchers (e.g. [21]) define a business ecosystem, following [22], as "the broader network of firms that influence how a focal firm creates and captures value". Prominent examples of ecosystems include Apple, Amazon, and WeChat. Platforms and ecosystems rely on a network of third-party entities to generate value for both direct customers and the partner network. This characteristic has led researchers to classify them as "open business models" following [2] and [23]. In the context of our research, we do not differentiate between these terms.

Research indicates that ecosystems present a concrete opportunity for improving business performance, while disregarding them can pose a tangible threat. A survey by BCG reveals that a quarter of executives anticipate that digital ecosystems will account for over 60% of sales in their industries within the next three years. The survey indicates that executives expect ecosystems to be particularly urgent and relevant in industries such as telecommunications, media and technology, finance, consumer goods, and healthcare, while industrials and energy sectors are seen as less urgent and relevant [8]. However, some authors [7] argue that the ecosystem trend is straightforward and applies to all industries.

Ecosystems are expected to generate additional value compared to more focused businesses in five key aspects of corporate performance. First, ecosystems should increase the size of the customer base [24; 25]. The logic is straightforward: the more products a firm offers, the larger the customer acquisition funnel becomes, especially if the firm's products are attractive to customers and have relatively low entry barriers, such as e-commerce, web search, or mes-

saging (which will be discussed in more detail in the next section of the paper).

The second aspect is increased customer loyalty, resulting in higher customer retention. Research has consistently shown that the more products a customer buys and the more frequent touchpoints they have with a firm, the more value is generated, and the less likely they are to leave for a competitor [26; 27]. As a result, many firms prioritize increasing engagement with their customer base, with customer relationship management (CRM) being one of the most popular applications of Big Data tools [28]. One of the main goals of CRM systems is to increase the number of touchpoints with customers at relevant points in time. Since an ecosystem typically offers a broader product range than a traditional business, the chances for increased frequency of contact with a customer are expected to be higher as well [15]. However, to the best of our knowledge, there has been no direct empirical research on the topic of customer retention specifically for ecosystems.

Third, since an ecosystem offers a broader product range, it should create more opportunities for cross-selling and, consequently, generate more value per customer [29]. Moreover, by providing more data on a customer's consumption, an ecosystem generates more data, which further increases opportunities for cross-selling [30]. Given the increased lifetime of a customer and higher opportunities for cross-selling, an ecosystem should, on average, have a higher overall customer lifetime value (CLTV). However, as with frequency and increased retention, there has not been, to the best of our knowledge, a dedicated quantitative study on the impact of ecosystems specifically on CLTV or cross-selling ratios in firms.

Fourth, ecosystems should exhibit higher resilience in times of crisis due to the diversified nature of their businesses. While there hasn't been a systematic review specifically on ecosystems, business diversification has been shown to be a viable strategy for increasing resilience [31]. However, evidence also suggests that if a company becomes too diversified, akin to a conglomerate, it may limit its upside potential while still bearing the downsides of non-diversified firms [32]. Therefore, it is important to differentiate between ecosystems and conglomerates when analysing their resilience.

Last but not least, ecosystems may yield benefits in terms of valuation. Research has indicated that firms acquiring fintech startups experience higher valuations [33]. Additionally, it has been argued that firms operating as digital players achieve higher and faster-growing valuations compared to their more conventional counterparts [34]. Therefore, it is reasonable to expect that successful ecosystems would command higher multiples compared to their conventional peers [35]. However, to the best of our knowledge, there has been no empirical research specifically addressing this topic. This aspect of valuation may be viewed either as a standalone source of value or as a result of successful ecosystem development.

Despite the potential benefits of ecosystems, only a few firms successfully establish them. According to research by BCG, less than 15% of ecosystems are sustainable in the long run, with 85% of failures attributed to poor ecosystem design [16]. Therefore, providing business practitioners with more data and guidance on ecosystem design is crucial. While empirical and conceptual research on the specific topic of optimal service composition for ecosystems is limited, there is literature available on the adjacent topic of customer lifecycle management that can inform our understanding. Most papers on customer lifecycle management highlight three key steps: customer acquisition, engagement, and retention [36–38].

At the customer acquisition stage, a firm invests resources to expand its customer base. Marketing remains a primary method for attracting customers, with extensive research dedicated to optimizing marketing spend across channels and customer segments for different industries. Sophisticated budget allocation strategies are employed even within social media platforms, as seen in studies on influencer marketing optimization [39]. Additionally, researchers delve into the nuances of digital marketing within financial institutions [40], while some underscore the significance of physical location even for digital companies [41]. However, marketing is just one facet of customer acquisition. Equally crucial is the development of an attractive product offering that provides value to the customer. For instance, retailers may utilize loss-making products as a hook to draw in customers for subsequent cross-selling opportunities, a strategy known as "loss-leader pricing" [42; 43].

During the customer activation stage of the customer lifecycle, firms employ various strategies, including CRM campaigns, to enhance the effectiveness of interactions with customers [44]. Additionally, firms aim to capitalize on existing customer relationships by cross-selling other products [45]. Moreover, savvy firms structure their product offerings to encourage frequent usage by customers, potentially at the expense of competitors' products. Loyalty programs, such as points or miles attached to a credit card, are commonly utilized for this purpose [46].

Despite firms' efforts, every customer has a finite lifetime as a client, a metric that varies significantly by industry and may range from several days to several years [47]. Nevertheless, firms strive to extend this period, leading to the final stage of the customer lifecycle, often referred to as "customer retention" [48]. The tools applied at this stage are essentially the same as those used during the customer activation stage, but with a different purpose in mind.

As we observe, existing customer lifecycle frameworks lack a dedicated step for the monetization of customer relationships, assuming that a firm tries to maximize value at every step. However, from a business perspective, it is crucial to constantly consider not only how to expand and maintain the customer base but also how to extract maximum value from customer relationships. A popular framework that can complement the customer lifecycle is the RFM (Recency, Frequency, and Monetary value) of the customer relationship (see, for example, [49]). This framework demonstrates that three factors of customer relationships drive success: how recently, how frequently, and for how much

money does the customer transact with the firm. While the RFM framework has primarily been used for focused firms, there is no reason why it cannot be applied to ecosystems.

In summary, the research literature demonstrates that ecosystems hold promise as a tool to enhance corporate performance by expanding the customer base, fostering loyalty, facilitating cross-selling, and enhancing business resilience and valuation. However, there is limited direct empirical evidence specifically focused on ecosystems, necessitating further dedicated research. Designing an ecosystem is a complex undertaking, and the majority of ecosystems fail due to poor design. Currently, there is no universally accepted framework for ecosystem design in the research literature. This paper aims to address this gap by proposing a framework and providing preliminary empirical evidence.

Framework Description

To develop our framework for ecosystem design emphasizing optimal business combinations, we integrate the five objectives of ecosystem launch (customer base growth, customer activation, cross-selling, business resilience, and valuation growth) with the three stages of the customer lifecycle (customer acquisition, customer activation, and customer retention), complemented by the concept of monetizing the customer base derived from the RFM framework.

It is evident that three out of the five ecosystem goals closely align with the stages of the customer life cycle. Goals 4 and 5 emerge as outcomes of successful ecosystem development. Therefore, we propose that companies aiming to achieve at least three ecosystem creation goals should prioritize the entire customer lifecycle, with an added emphasis on monetizing the customer base.

First of all, a firm should offer a business line or a suite of products designed to attract customers, often referred to as "*hook products*" [50]. While these products may not always yield significant profits or could even operate at a loss (following the loss-leader strategy mentioned earlier), their primary function is to expand the customer base. Some companies may opt to offer these products for free. Examples of such products within an ecosystem context include free search engines like Google or Bing, or free apps available on platforms such as WeChat. It is crucial that these products have minimal barriers to initial usage. For instance, for a bank, a debit card or basic payment service represents a low-barrier product, requiring minimal customer analysis during onboarding and offering clients a swift introduction to the product. This explains why many fintech startups initially launch with such products (e.g., Revolut, PayPal, N26, etc.) [51]. Conversely, a mortgage would be an ill-suited hook product due to its complexity and higher associated risks.

Secondly, an ecosystem should incorporate a business line or product aimed at increasing the frequency of customer interaction. We refer to these products as "*engagement products*". Their purpose is to create regular touchpoints with ecosystem services. Examples of such products include e-commerce platforms or marketplaces, where customers frequently browse for new products. Even if customers don't make immediate purchases, their ongoing engagement with the service increases the likelihood of spontaneous purchases triggered by promotions or advertising. Another example is messaging apps like WeChat or Kakao, which customers use multiple times per hour, maintaining high levels of engagement. Conversely, services with relatively low levels of engagement include telecommunications and cell phone operators. Despite constant usage by customers, they involve minimal conscious interaction with the ecosystem, resulting in passive engagement.

Finally, once the ecosystem has acquired customers and engaged them with its products or services, it should focus on *monetizing* its customer base. There are various strategies to achieve this goal. One common approach involves cross-selling high-margin products. Many banks employ this strategy, initially attracting customers with low-margin products such as basic payment services and then cross-selling higher-margin products like credit cards or personal instalment loans [51]. In ecosystems comprising multiple business lines, this strategy can be even more effective, leveraging the large customer base acquired through "hook" products like messaging apps or search engines to monetize relationships with higher-value-added products such as banking and lending. Kakao Bank in South Korea, among others, has successfully implemented this approach [52]. We explore similar models in the next section of this paper.

To summarize, ecosystems represent new types of business groups. The latter are well known in corporate finance by their *internal capital markets* that may have "bright sides" (see e.g. [53] such as the ability to transfer capital between firms instead of private investors, to appropriate private benefits partially for themselves from several projects simultaneously, to create more incentives to transfer funds to better projects, leading to better capital allocation as well as greater capital expenditure capacity due to a lower volatility of cash flows, higher coverage of debts and lower financing risks, and finally to lower financial constraints. However, the specific structure and decision-making rules in business groups may generate a "dark side" of corporate decisions (see e.g. [54]) related to new nodes of agency conflicts when investment decisions and capital transfer are driven by the need to mitigate conflicts between power echelons inside the group. Ecosystems employ diverse strategies and service combinations to achieve the common goal of constructing an integrated portfolio of businesses catering to the diverse needs of their clients, thereby fostering resilient enterprises. Using new policies for improving the customer base and customer leverage, ecosystems gradually create specific "internal product markets". In these "markets" clients shop for diverse products of the ecosystem's business lines, while the business lines "pitch" their products to customers. Regulating these "markets" is not unlike regulating internal capital markets in holding

structures. However, instead of managing capital, an ecosystem needs to manage clients and product distribution in order to maximize value. To this end ecosystems employ a diverse set of tools that we will discuss later in the paper.

The approaches to building ecosystems and these "internal markets" vary depending on the ecosystem's history and evolution. For instance, some ecosystems initially focus on low-margin businesses and later introduce monetization products, as seen with Mercado Libre [55]. Conversely, others add customer acquisition vehicles to existing high-margin businesses, exemplified by Kaspi in Kazakhstan [10].

Additionally, certain businesses can serve as both hook and engagement products simultaneously. E-commerce is a prime example of such a dual-function business. It not only presents a relatively low barrier for customers but also fosters ongoing engagement with them. This duality may explain why many ecosystems incorporate e-commerce in some form as one of their business lines.

Another crucial aspect to consider is that constructing an ecosystem entails more than just gathering a collection of businesses that, theoretically, fulfil all the steps outlined in the proposed framework. If these businesses lack interconnectedness or cater to disparate customer groups, one could contend that such a firm resembles *not an ecosystem* but rather a *conventional conglomerate*. In such cases, instead of commanding a valuation premium, the firm may suffer from what is known as a conglomerate discount – a widely acknowledged and enduring phenomenon [56; 57].

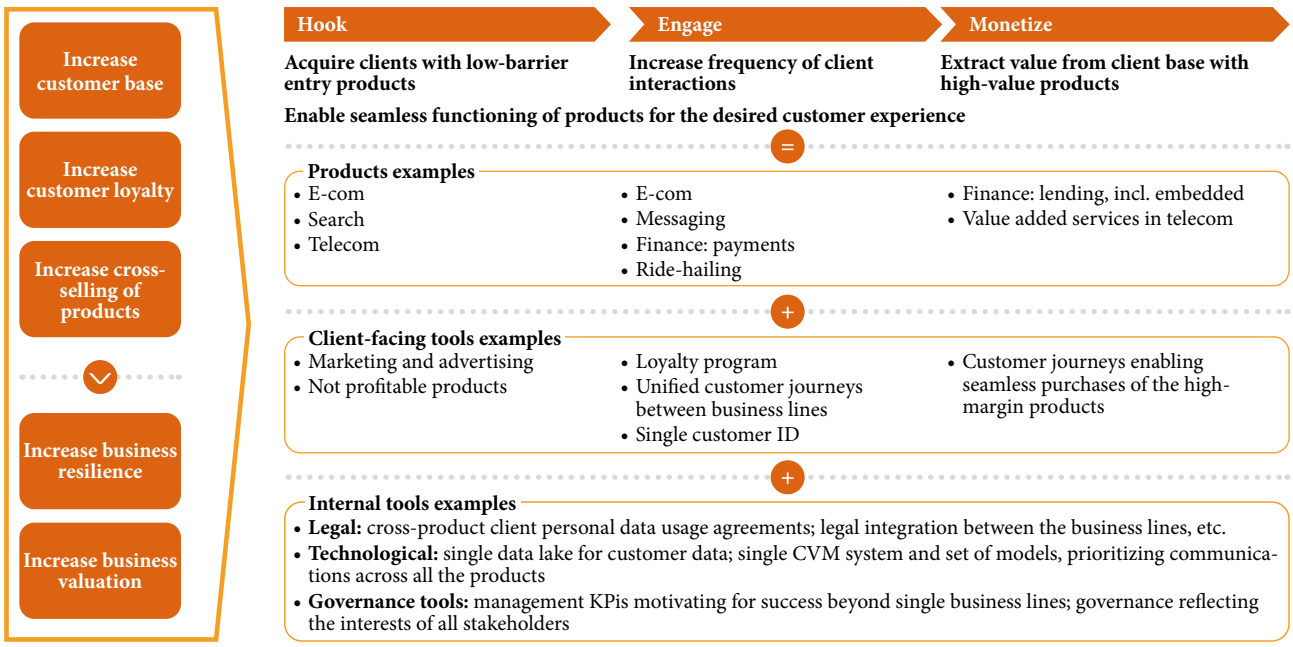
Achieving seamless integration between ecosystem services often requires the application of different tools, both internal and customer-facing. Customer-facing tools include unified identification processes across all services, a single loyalty program encompassing all products and services, and customer journeys designed to facilitate the seamless utilization of multiple ecosystem products within a single experience.

A crucial internal tool for the efficient functioning of a firm within an ecosystem is a unified Customer Relationship Management (CRM) or Customer Value Management (CVM) system, which relies on a single database encompassing all customer actions and transactions. Implementing such a system involves a complex constellation of legal agreements, requiring customer consent for data usage across all services, as well as technical integration, managerial oversight, and governance protocols. The complexity of developing such a system is compounded by the gradual evolution of ecosystems over time, often through a series of mergers and acquisitions. Additionally, many ecosystems operate as joint ventures with external vendors and partners that legally exist outside the perimeter of the core firm, further complicating the integration process.

In the diagram below, we outline the framework for an effective ecosystem and present both internal and external tools and mechanisms essential for success. At the top of the diagram, we reaffirm the five goals of ecosystem development. The framework consists of three layers corresponding to the suggested steps: Hook, Engage, and Monetize. The first layer represents the composition of businesses within the ecosystem; the second layer comprises customer-facing business tools; and the third layer encompasses internal corporate tools.

It is important to address another aspect of ecosystem performance, namely, how success is measured. A key distinction must be made between metrics used for internal management purposes and those accessible to external stakeholders such as investors or analysts. The first group of metrics primarily focuses on the direct impact of the

Figure 1. Proposed HEM framework for ecosystem analysis



ecosystem on customers. These include the following metrics: customer acquisition cost by business line; customer activity level (measured by metrics such as the number of transactions per month); proportion of customers using products from multiple business lines; customer churn rate; and customer lifetime value. These metrics should be analysed for customers using one versus multiple products within the ecosystem, as well as tracked over time. Such analysis provides management with insights into whether the ecosystem is delivering tangible results.

The second group of metrics is accessible to a firm's external stakeholders. They tend to focus on outcomes and are therefore less direct. For example, the relative size of the business lines in terms of revenue or customer base. A more or less balanced distribution among business lines suggests the presence of an ecosystem, rather than a firm with a single business line with minor additions. However, it is important to note that reporting the breakdown of business segments is often at the discretion of the firm. While successful ecosystems may be more inclined to report such data, the decision to do so is typically guided by internal corporate policies rather than general accounting rules. Consequently, this reporting practice may introduce bias into studies examining ecosystem performance.

The third group of metrics involves market valuation. A higher valuation, indicated by conventional metrics such as the Market-to-Book Value of Equity, or the Price-to-EBITDA or Price-to-EBITDA-to-Sales ratio compared to similar firms focused on standalone business lines, suggests that investors are endorsing the ecosystem narrative of the firm. This can be interpreted as a measure of ecosystem success, as insiders and investors typically have more access to firm information than external analysts. An extension of this metric involves comparing the firm's overall valuation to a sum-of-parts valuation by business line, if such data is available. In this paper, we apply our framework to several case studies across different markets to ascertain whether firms adhering to our ecosystem design framework indeed achieve better results.

Case Study Approach and Sample Selection

In this section of the paper, we outline the methodology employed to evaluate the effectiveness of the derived framework in analysing ecosystem design. We chose the case study approach for several reasons. First of all, ecosystems exhibit considerable diversity in business composition, influenced by factors such as local context, the unique developmental trajectory of individual firms, and the capabilities within each firm. Secondly, in most markets, the number of ecosystems is inherently limited because, by design, an ecosystem offering a diverse range of services utilized by numerous clients tends to be a major player. This is analogous to markets such as telecommunications, where it has been established that an optimal number of players is typically 3 or 4 [58]. However, we are not yet able to determine the optimal number of ecosystems per market. Consequently, conducting a quantitative study comparing ecosystems across diverse markets would be challenging due to potential significant differences in accounting rules and market contexts.

Thirdly, due to the absence of a single comprehensive data source on ecosystems and their business compositions, our analysis relies on parameters that may vary between firms to derive insights. Additionally, ecosystems may not always disclose the parameters required by researchers to conduct analysis on ecosystem efficiency.

Among the aspects of ecosystem operations outlined in the HEM framework in Part 2, our research primarily concentrates on the externally visible facets of operations, namely, the array of business lines within the ecosystem and the customer-facing attributes such as loyalty programs and customer journeys. Due to data constraints, we do not explore the internal operations of firms invisible to external stakeholders. However, any available data in this regard is catalogued for potential use in future research.

For each of the cases, we undertake a study of the existing business structure and the achieved results. Our analysis follows several steps. First, we examine the spectrum of products and services provided by the ecosystem, along with the historical context of business line launches, where applicable. Each business line is categorized according to its alignment with the framework: Hook, Engage, or Monetize. It is noteworthy that certain business lines, like e-commerce, may span across multiple parts of the framework. Our primary data sources include official reports for investors, such as investor days accessible on company websites. We complement this information with online research and insights collected from 20 unstructured expert interviews related to the ecosystems under study, where experts were available.

Second, we assess the client-facing tools utilized by the firms, including unified identification systems, cross-product customer journeys, and loyalty programs, to determine their presence or absence. To gather this data, we adopt a "mystery shopping" approach, engaging with the services offered by the firms under investigation. Additionally, we supplement our findings with information obtained through web searches and content available on the official websites of the firms. In this study, we refrain from evaluating the usability of these services, because such an assessment would require either an objective methodology or access to a single source of information. Therefore, our focus remains on acknowledging their presence or absence, leaving the assessment for potential future research endeavours.

Afterwards, we analyse the firm's performance in achieving the targets set for the ecosystem and assess whether it receives a market premium compared to standalone businesses. We gather data on valuation multiples from publicly available sources such as Yahoo Finance. In our sample, we find several ecosystems that attempted to develop adjacent business lines but ultimately closed them. Regardless of the comparative analysis of valuation multiples, we consider these cases as non-successful.

The analysed sample comprises nine cases of successful and less successful ecosystems from different countries, including Argentina (Mercado Libre), Kazakhstan (Kaspi), South Korea (Kakao), Malaysia (Grab), France (Orange), Japan (Rakuten), India (SBI), UAE (Mashreq), and Spain (BBVA).

We deliberately excluded some of the best-known ecosystems, such as Apple, Amazon, Uber, WeChat, Alibaba, and others. Additionally, we chose not to include the largest markets – the USA and China. There were several reasons for this decision. First of all, we aimed to broaden the understanding of global ecosystems, illustrating that, while Chinese firms often dominate discussions (see, e.g., [59]), the ecosystem phenomenon is much larger in scope. Secondly, including the largest global ecosystems could skew benchmarking, as their success may be influenced by international markets, whereas the ecosystems in our sample are more localized. The results of our analysis are provided in the next section of the paper.

Framework Application Results

In this part, we summarize the results of the case studies. First, let us give some basic information about the firms in question (in alphabetical order).

BBVA, a major global bank originating from Spain, embarked on a strategic initiative to modernize its services and attract a younger clientele. Recognizing the rapid evolution of banking driven by fintech advancements, BBVA pursued a series of investments and mergers with startups to cultivate an ecosystem offering enhanced value propositions for customers [60]. For instance, BBVA launched Simple, a neobank in the USA, as well as establishing a $100 million in-house venture capital (VC) fund [61]. Despite the subsequent closure of both Simple and its VC fund, BBVA persisted in investing in new technologies and collaborating with venture capital firms to counteract market commoditization [62]. Notable apps introduced by BBVA include Valora, which provides augmented functionality for real estate transactions, and Boconomy, an innovative personal finance management tool [63]. These services feature integrated customer journeys within the main BBVA offering, albeit primarily serving as supplementary features within banking services rather than constituting major new business lines. While BBVA has numerous peers, banks Santander and CaixaBank, both from Spain, are arguably its closest competitors.

Kaspi is the leading retail bank in Kazakhstan in the number of customers. Initially operating as a traditional retail bank, Kaspi underwent a complete transformation by introducing several fintech innovations to the local market, which most notably led to a transition of the entire market from plastic cards and NFC payments to QR code payments. Subsequently, Kaspi expanded its offerings by incorporating a significant e-commerce business, which serves as both a client acquisition channel and a platform for deeper customer engagement. The monetization of customer relationships continues to rely heavily on unsecured lending. A notable strength of Kaspi's offering lies in its tightly integrated user experience, complemented by a cashback-based loyalty program. While Kaspi has several peer banks in the Kazakhstani market, the only publicly traded one is Halyk Bank. Another comparable institution is TBC Bank, a Georgian neobank operating across multiple post-Soviet states. Kaspi's valuation is not directly compared to other e-commerce players, as over 71% of its net income is still generated from financial services [64].

Kakao, originally established as a messenger platform in South Korea, gradually diversified its portfolio by incorporating multiple business lines, including money transfers, e-commerce, banking, and eventually ride-hailing services. While Kakao already boasts a sizable customer base, it continues to expand its reach, particularly targeting younger generations through successful media projects and engaging clients via its messenger platform and user-friendly e-commerce services. Monetization still occurs primarily through traditional banking products. Similar to Kaspi, Kakao offers a seamlessly integrated user experience with a single client ID and integrated customer journeys. Given Kakao's extensive diversification, it is challenging to identify a perfect match. However, since a significant portion of Kakao's business is driven by banking services, we compare it to the largest banks in the market, such as Shinhan and Hana.

Mashreq, a prominent bank in the UAE, has initiated a strategic shift to offer services beyond traditional banking, aiming to enhance customer value and streamline the customer acquisition process. Still in the early stages of this transition, Mashreq has many peers in the local market. We compare it to the largest bank in the country, First Abu Dhabi Bank (FAB), as well RAKBANK.

Mercado Libre, sometimes referred to as the "Amazon of Latin America" [65], is a prominent ecosystem based in Latin America, with its headquarters in Argentina. Unlike Amazon, which historically has focused on e-commerce, Mercado Libre expanded its offerings to a comprehensive suite of financial services, notably around its Buy Now Pay Later (BNPL) product available on the marketplace. This expansion has led to tightly integrated customer journeys and a unified loyalty program based on points earned through platform transactions. With two comparably sized business lines, Mercado Libre is compared to two distinct sets of firms: banks (Grupo Financiero Galicia and NU bank) and e-commerce platforms (Casas Bahia, Americanas on nm, and Magazine Luiza S.A.). It is important to note that while banks are typically evaluated based on the market to book value of equity, marketplaces are assessed using the price to total sales ratio.

Orange, one of the largest global telecommunication operators, encountered the common industry challenge of commoditization, where telecom companies risk becoming mere conduits for internet traffic, while internet giants reap the benefits [66]. In response, Orange sought to leverage its substantial customer base by entering the banking sector – a common strategy among telecoms aiming to

diversify revenue streams. However, like many of its peers, Orange struggled to transition its customers to banking products and ultimately shuttered its banking venture [67; 68]. Orange's peers are telecom players such as Bouygues and Vodafone. The conventional benchmark metric for telecoms is the price to earnings ratio.

Grab, initially established as a ride-hailing service in Malaysia, rapidly expanded its presence across various Asian markets, transforming the ride-hailing industry in each country it entered. However, Grab's ambitions extended beyond ride-hailing, as it ventured into adjacent sectors such as food delivery and finance. In finance, Grab diversified its offerings by facilitating retail payments and extending lending services to SMEs through strategic partnerships. Notably, Grab acquired a 90% stake in OVO, a fintech-focused ecosystem that has been called the largest ecosystem in Indonesia [69]. Grab's customer journeys are seamlessly integrated within its superapp, supported by a comprehensive loyalty program. Given that the majority of Grab's business still revolves around ride-hailing, its closest peers are arguably Uber, Lyft, and DiDi.

Rakuten, a diversified ecosystem originating in Japan, initially established itself as an e-commerce platform before moving into financial services, with fintech contributing up to 40% of its revenue, notably through Rakuten Card, which is integrated with Rakuten's world-class loyalty program. Additionally, Rakuten operates as a telecom operator, further augmenting its ecosystem offerings. Rakuten's customer journeys are tightly integrated, with the loyalty program incentivizing usage across multiple services. While Rakuten does not have any direct peers, it is pertinent to compare it to large Japanese banks such as Mitsubishi, Sumitomo Mitsui, and Mizuho Financial Group, as well as marketplaces like Mercari and Zozo.

State Bank of India (SBI) stands as one of the largest banks in India. Similar to BBVA, it opted to diversify its operations beyond core banking to augment its customer base. Diverging from the predominant focus on B2C customers seen in many ecosystems analysed in this paper, SBI tailored its ecosystem around B2B clientele, particularly SMEs. Among its notable initiatives is Krishi Yono, which enables Indian farmers to vend their produce to large buyers. This platform not only offers farmers a practical means of selling goods but also provides access to valuable information such as pricing and weather forecasts. For the bank, Krishi Yono yields valuable transactional data that facilitates lending processes – a challenging endeavour, especially within the SME sector in emerging markets. SBI's peer banks include Axis Bank and ICICI.

A summary of our analysis is presented in Table 1. It should be noted that, in the assessment of monetization, our focus is exclusively on offerings explicitly designed for selling high-margin products, such as unsecured lending. Monetization avenues such as advertising space (digital or physical) or the sale of aggregated customer data are not included in the analysis.

Our analysis of the nine ecosystems shows that four of them outperform their peers (Kaspi, Kakao, Grab, Mercado Libre), three exhibit results that are comparable to that of their peers or mixed depending on the valuation metric used (BBVA, Mashreq, Rakuten), and two lag behind their peers (Orange and SBI). As Table 1 shows, almost all successful ecosystems have diversified business lines covering all three stages of the customer lifecycle, supported by dedicated services tailored to each stage. Additionally, the vast majority of successful ecosystems (with the exception of Mashreq) employ unifying tools such as a single ID, integrated loyalty programs, and/or unified customer journeys. These successful ecosystems boast valuation multiples up to nearly 8 times higher than their peers (Kaspi).

The less successful ecosystems exhibit quite different profiles. A notable observation is the absence of a viable engagement product among these ecosystems. All of the ecosystems that underperform their peers or show results on par rely (or relied) heavily on conventional products from their original line of business (e.g., payments) or lack a dedicated engagement product altogether (such as Orange).

It is plausible to suggest that ecosystems without a significant difference in valuation multiples compared to their peers have not developed additional business lines substantial enough to be distinctly noticeable alongside their main lines of business. In essence, these additional offerings may be perceived more as features rather than standalone business lines. It is important to acknowledge that the variations in valuation multiples may stem from different factors and would benefit from a quantitative study, such as event study methodology, which we plan to conduct in the future.

Conclusions

In this paper, we explored digital-based business model transformation, focusing on ecosystem business models. Drawing insights from existing research in related fields such as the customer lifecycle and RFM approaches, we formulated a framework for analysing efficiency and selecting business lines and tools for ecosystem design. This contribution is particularly significant given that flawed design has been identified as a major factor contributing to ecosystem failure. To complement the framework, we also proposed methods for measuring ecosystem performance using open data sources. Our study applied this framework to analyse nine cases of ecosystems from nine different countries, aiming to determine whether its application facilitates differentiation between successful and unsuccessful ecosystem designs.

The derived framework suggests that, to be successful, an ecosystem should have three types of business lines: 1) Hook products with high attractiveness and low entry barriers that consistently bring significant numbers of customers to the firm; 2) Engagement products that increase the frequency of interactions with the firm's products and thus extend the time that a customer spends with the firm (the so-called "customer lifetime"); and 3) Monetization products that allow an ecosystem to extract maximum value from the existing customer base.

Table 1. Summary of case study results

Ecosystems that outperform their peers are highlighted in green, those with similar or mixed results (depending on the multiple) are shaded in grey, and those that underperform are marked in orange.

General information on the ecosystem					Key business line composition			Customer-facing features			Ecosystem's results[17]	Peers' results
#	Ecosystem	Country of origin[1]	Original business line[2]	Key business lines[3]	Hook products[4]	Engagement products[5]	Monetization products[6]	Loyalty program[7]	Unified ID[8]	Unified CJs[9]	Valuation multiple[10]	Peer multiples[11]
1	BBVA	Spain	Fintech[12]	Fintech	Value-added services like AR for real estate	Fintech (payments) PFM	Fintech (lending)	No	Yes	Yes	P/B[14] = 1.0	P/B = 0.7
2	Kaspi	Kazakhstan	Fintech	Fintech	E-commerce	E-commerce	Fintech (lending)	Yes	Yes	Yes	P/B = 8.3	P/B = 1.0
3	Kakao	South Korea	Messenger	Fintech Entertainment Ride hailing	Messenger Media	Messenger Ride hailing	Fintech (lending)	Yes	Yes	Yes	P/B = 2.1	P/B = 0.4
4	Mashreq	UAE	Fintech	Fintech	Value added services for corporate clients	Fintech (payments)	Fintech (lending)	No	No	Yes	P/B = 1.1	P/B = 1.2
5	Mercado Libre	Argentina	E-commerce[13]	E-commerce Fintech	E-commerce	E-commerce	Fintech (lending)	Yes	Yes	Yes	P/B = 29.0 P/S[15] = 6.1	P/B = 4.1 P/S = 2.0
6	Orange	Spain	Telecom	Telecom	Telecom	-	Fintech (closed)	No	Yes	No	P/E[16] = 12.8	P/E = 16.4
7	Grab	Malaysia	Ride-hailing	Ride-hailing Fintech	Ride-hailing Delivery	Ride-hailing Delivery Fintech (payments)	Fintech (lending)	Yes	Yes	Yes	P/S = 3.8	P/S = 0.9
8	Rakuten	Japan	E-commerce	E-commerce Fintech Telecom	E-commerce Telecom	E-commerce	Fintech (lending)	Yes	Yes	Yes	P/B = 1.4 P/S = 0.7	P/B = 0.7 P/S = 3.5
9	SBI	India	Fintech	Fintech	Value added services for corporate clients	Value added services for corporate clients	Fintech (lending)	No	Yes	Yes	P/B = 0.8	P/B = 2.7

Notes: 1. Country of origin – country of initial ecosystem launch, possibly not the main country of business presently; 2. Original business line – business line that was the first for the ecosystem, possibly not the business line generating the most revenue or profit presently; 3. Key business lines – business lines generating most of the revenue; 4. Products with low barriers to enter the ecosystem, which are perceived as the customer acquisition vehicle; 5. Products that by their nature create substantial engagement with the customer base; 6. Products that generate high margins and allow to extract value from existing customer relationships; 7. Whether an ecosystem has a loyalty program integrated across the different lines of business; 8. Whether an ecosystem has a single identification tool used to log in to all the services; 9. Whether an ecosystem has customer journeys integrated across several products, possibly in the form of a superapp or a constellation of apps; 10. Suggested valuation multiples for the ecosystem and their values; 11. Average valuation multiple of the selected peer group. 12. Fintech – any financial service, including payments, lending, savings, insurance, etc. 13. E-commerce – any type of e-commerce, including sales of own goods or a marketplace for third party sellers; 14. P/B – Market Capitalization / Book Value of Equity; 15. P/S – Total Enterprise Value / LTM Total Revenue; 16. P/E – Normalized Price / Earnings Per Share; 17. Ecosystems that outperform their peers are highlighted in green, those with similar or mixed results in grey, and those that underperform in orange. Source of all data: S&P Capital IQ, except data on Rakuten, which is taken from Yahoo Finance (accessed on 2024-05-30); date: end of 2023.

In addition to these business lines, a firm should have a set of internal and client-facing tools that tie the business lines together. Client-facing tools include: 1) a single ID for ecosystem products; 2) unified customer journeys enabling seamless transitions between products; and 3) a single loyalty program for stimulating the usage of multiple products. Internal tools include 1) Unified Customer Relationship Management (CRM); 2) legal agreements between business lines; 3) technical integrations between business lines; and 4) proper managerial and governance set-up.

The case studies show that the framework developed in this study holds potential as a tool for assessing the efficiency of existing ecosystem designs. Moreover, it offers valuable insights for making strategic decisions regarding the launch of business lines when aiming to build an ecosystem. Several key findings emerge from the analysis.

First of all, the analysed cases suggest that, when constructing an ecosystem, firms with significant customer bases should prioritize launching or expanding business lines that encourage frequent and conscious interactions with the ecosystem. Neglecting this aspect and focusing solely on monetization tools and strategies often results in subpar outcomes.

Secondly, firms with established high-margin businesses may derive benefits from introducing a business line that serves as an acquisition vehicle, characterized by low entry barriers for customers ("hook product"). Ideally, this product should also serve as an engagement tool. E-commerce exemplifies such a service, being attractive both as a hook product and as an engagement product. This dual role may explain its presence in many ecosystems.

Thirdly, the development of tools that integrate various components of the ecosystem is a crucial factor for success. These tools, such as a single ID, seamless customer journeys, and loyalty programs, serve to unify diverse businesses within the ecosystem. Without such integration, the ecosystem may function more like a conglomerate of disconnected entities, leading to suboptimal performance.

Fourthly, when introducing a new business line to establish an ecosystem, it is important to ensure that this addition carries enough weight to be significant within the overall business framework. If the new business line is not substantial enough, it may be overlooked at the corporate level, leading to the risk of this new line shutting down as unsuccessful.

While we believe that the findings of this study offer valuable insights for business practitioners, it is important to acknowledge several limitations inherent in our research approach. First, in our case study methodology, we primarily synthesized publicly available information. Consequently, we could not directly assess the significance of internal ecosystem tools like unified CRM. Second, while the case study method allows for in-depth exploration of firms' experiences, it lacks the advantages of quantitative studies, such as the ability to draw more generalized conclusions and forecasts. Third, our analysis was limited to only nine ecosystems, whereas there are numerous others worthy of exploration. Our research would greatly benefit from selecting successful and less successful ecosystems from the same or similar markets and contrasting their experiences. Fourth, conducting robustness checks on the differences in valuation premiums using methodologies like event studies would enhance the credibility of our conclusions. Fifth, obtaining more detailed performance information through insider interviews, such as profitability by business line and customer churn rates, would undoubtedly enhance the depth of our study.

Acknowledging these limitations, we remain confident that this research will make a valuable contribution and are committed to addressing the identified gaps in subsequent studies.

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The Impact of Foreign Investment Components on Cash Holdings

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Abstract

This study examines the impact of foreign investment components – institutional foreign investment, individual foreign investment, and Global Depository Receipts (GDRs) – on firms' cash holdings. The sample comprises non-financial companies listed on the Egyptian stock market across 12 sectors during 2014–2024. Panel data are analyzed using ordinary least squares with fixed effects and verified through two-stage least squares estimation. The results indicate that individual foreign investment has a positive and significant effect on firms' decision to hold cash, whereas GDRs exert a negative influence. Institutional foreign investment shows a positive but statistically insignificant effect. These findings suggest that different types of foreign investors play distinct roles in shaping corporate liquidity policies. The study provides practical implications for policymakers and regulators. Evidence can inform policies that balance the costs of cash retention with the benefits of financial flexibility in the presence of foreign investment. It also offers guidance for regulatory bodies seeking to attract foreign investment while ensuring efficient liquidity management. For foreign investors, the results highlight the influence of their investment channels on firms' financial behavior. By focusing on the Egyptian context, the research contributes to the limited literature on the relationship between foreign investment and cash holdings in emerging markets. The findings expand the understanding of how corporate financial policies respond to diverse investment flows in less developed institutional settings.

Keywords: institutional foreign investment, individual foreign investment, global depository receipts (gdrs), cash holdings, two-stage least squares method
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Introduction

Foreign capital plays an important role in emerging markets. Countries are trying to attract more foreign investments by setting policies at the country level, such as protecting the rights of investors, improving the legislative and legal environment for investment, as well as setting policies at the level of companies related to improving levels of transparency and disclosure, corporate governance mechanisms, and adopting International Financial Reporting Standards (IFRS). The characteristics of companies that may affect their financial decisions include the decision of cash holdings. One of the most important characteristics of companies is their ownership pattern. This is because the ownership structure is one of the factors affecting the decisions and policies of the company. More specifically, one of the most important ownership structures for companies is the structure of foreign ownership. Foreign ownership means that the company is owned and / or controlled by a group of foreign investors. [1] found that foreign ownership significantly increases the probability of meeting or exceeding market expectations in terms of profits. Companies in which foreigners own a large portion try harder to satisfy investors who care about current profits by increasing the share price. On the other side, [2] demonstrated that foreign investors play a major role in limiting the management of profits from actual activities, since foreign investment improves accounting control. In addition, there are no caveats that prevent the foreign investor from investing in the Egyptian Stock Exchange. This is a result of the notion that he is treated like an Egyptian investor, and no taxes are imposed on foreigners who invest in the stock exchange. Likewise, all companies registered on the Egyptian stock exchange are treated similarly, whether they are Egyptian or foreign.

Foreign investment in the Egyptian capital market is divided into three components: namely Institutional foreign investment, Individual foreign investment, and Global Depositary Receipts (GDRs). Many companies have resorted to issuing GDRs in global financial markets. GDRs are a financial instrument derived from the shares listed on the Egyptian Stock Exchange with the aim of providing the opportunity to trade companies on several international stock exchanges. Some Egyptian companies' shares are traded in the form of GDRs on foreign stock exchanges, such as London Stock Exchange, New York Stock Exchange or Luxembourg Stock Exchange. According to the stock exchange's annual report[1] 2020, 2021, and 2022, foreigners were engaged in 28, 27, and 31%, respectively, of the transactions and trading of the Egyptian Stock Exchange. According to the 2021 stock exchange report, individuals accounted for 26% of total stock market transactions, including 24% for Egyptians and 2% for foreigners, while institutions accounted for 74%, including 49% for Egyptian institutions and 25% for foreign institutions.

Cash is considered one of the most liquid and least profitable assets in circulation [3–4]. Cash is also one of the most dangerous accounts due to its association with many accounting transactions, as well as the ease of its exploitation in comparison with other assets. Therefore, it is of great importance for many company stakeholders to assess the company's ability to fulfill its obligations, distribute profits, face the risks of unexpected fluctuation, hedge against it, and exploit investment opportunities [5]. Foreign ownership leads to an increase in the motivation of foreign investors to achieve high returns from managing the company's assets, other than cash, due to the low return achieved from cash management compared to other assets in the company. Foreign ownership also leads to an increase in the ability of foreign investors to oblige the company to reduce cash balances [3; 6–8].

Many previous studies have addressed the relationship between foreign investment and cash holdings. Studies have found that foreign ownership has several beneficial effects for investing firms, i.e., it contributes to long-term firm value enhancement, lowers the cost of capital, and improves corporate governance. For example, [9] found that foreign investment in the Vietnam Stock Exchange has a positive impact on cash holdings, and that it enhances firm value in the long run. [10] also found that foreign institutional investors in the Pakistan Stock Exchange positively influence the contribution of excess cash holdings to firm value and support corporate governance. [11] marked, that foreign investors hedge against risks in the home country resulting from economic and political uncertainty through outward investment. Furthermore, relative uncertainty in foreign economic policy negatively impacts the cash holdings of host country firms by influencing managerial decision-making.. [12] found that foreign investment has a negative impact on cash holdings of Pakistani firms listed on the capital market in 2013–2018. [13] found that foreign direct investment (FDI) inflows have different impacts on the cash holdings of international firms. [14] found that foreign-owned firms in Malaysia have higher R&D intensity when their cash holdings are high. The research aims to study the impact of foreign investment components on determining cash holding policies for companies listed on the Egyptian Stock Exchange. The research question is: do various components of foreign investment affect the level of cash holding of companies listed on the Egyptian Stock Exchange?

This study makes several contributions. First, it adds to the financial literature by highlighting the impact of each type of foreign investment on firms' cash holding decisions in developing countries. Second, it expands the theoretical understanding of this relationship by explaining firms' cash holding behavior when foreign investment is present. Third, understanding the relationship between foreign investment and cash reserves helps companies strengthen governance mechanisms and attract more investment. In addition, the study provides practical evidence to help corporate decision-makers, regulatory bodies, and investors understand the role foreign investment components

[1] URL: https://www.egx.com.eg/ar/services_reports.aspx

play in influencing cash retention policies. The structure of the study is organized into five parts: the introduction in first part, the theoretical basis of the paper is elaborated in second part. Third part addresses research hypotheses development, while fourth part presents research design and discusses the results. Fifth part outlines concluding remarks, implications and future directions.

Theoretical Background

Foreign investment is defined as the percentage of shares owned by foreign investors who play an important role in controlling the management of the company. Therefore, foreign investment is expected to reduce information asymmetry and agency problems [15]. Foreign investment plays an important role in emerging financial markets, as it works to ensure liquidity and efficiency in these markets by increasing the supply of capital. Foreign investors are distinguished by their ability to help in transferring advanced modern technology and expanding the scope of expertise, knowledge and know-how. This is due to the capabilities, decisions, resources and ability to access global markets available to foreign investors. Also, foreign investors from countries that have high-quality governance mechanisms and laws have experience with company monitoring and improving the level of governance in the company. In addition, foreign investors put great pressure on managers to modify their behavior towards serving the interests of shareholders, due to the power of the foreign investor to control management decisions and actions [9; 10: 16]. Therefore, the role that foreign investment plays in developing countries is considered important and effective in strengthening corporate governance and reducing agency costs. However, on the other hand, foreign investment has many disadvantages, including some foreign investors' keenness to achieve quick profits, focus on short-term decisions, and seek to achieve their own interests at the expense of the interests of the rest of the shareholders. Foreign investors also face many economic, political, and other risks, especially when investing in countries with volatile and emerging economies. In addition, the geographical distance of these foreign investors and the lack of information may prevent them from monitoring the actions and behaviors of executive directors.

Cash is the most important strategic asset that helps companies seize future investment opportunities and meet unexpected contingencies in times of uncertainty. Cash provides companies with the opportunity to maintain a buffer against uncertainty and reduce dependence on external funds [4]. Cash is held for a number of motives, including first of all, the transaction motive, where cash provides the necessary liquidity to meet the obligations resulting from operational processes, and to make regular payments. Secondly, it is the precautionary motive, where cash is kept as a safety margin to hedge against unexpected risks, to secure the necessary financing for investment opportunities, especially when external financing is expensive. Thirdly, it is the speculation motive, where cash is held to provide liquidity with the aim of seizing and exploiting profitable investment opportunities that may occur in the future. Next is the agency motive: as the level of cash held increases in companies that suffer from agency problems resulting from conflicts of interest between owners and management or between small owners and large owners. And last is the tax motive, where multinational companies hold cash, since they make foreign profits that are subject to high taxes in the country of the parent company, while the tax rate in the country where they are registered is lower. Therefore, these companies prefer to hold cash in their country of registration because the tax rate is low, instead of returning it. This money is transferred to the parent company and bears a high tax burden. Companies convert foreign assets into cash to avoid the high taxes resulting from returning foreign revenues to the home country, which leads to a decrease in the tax burden [17-19]. Also, the decision to hold cash is associated not only with the company's operations, but also with the level of corporate governance and the institutional environment. The decision to hold cash depends not only on the company's internal environment but also on the external environment in which the company operates [20].

Research Hypotheses Development

Foreign investments are an important monitoring tool on management behavior. The executive management may carry out some practices that would serve the interest of management at the expense of other stakeholders or serve the interests of some of the company's stakeholders at the expense of others. A number of studies have found a relationship between foreign investment and the decision to maintain cash holdings. [21] found that foreign investment negatively affects cash holdings in a sample of 100 companies in the Kingdom of Saudi Arabia. On the other side, [9] found that there is a positive effect of foreign investment in the Vietnam Stock Exchange on cash holdings. The researchers explain the expected relationship between the components of foreign investment and the decision to maintain cash holdings as follows.

Institutional Foreign Investment and Cash Holdings

Institutional foreign investment means that a company is owned or controlled by a foreign institutional investor such as banks, insurance companies, investment funds and other foreign institutions. The foreign institutional investor can be a financial or non-financial institution. There are many studies that provide evidence of the correlation between foreign investment and improving control over the actions of managers. [22] found that foreign investors play a role in improving the level of corporate governance, which leads to an increase in company value. In the same direction, [23] pointed out that foreign investment is linked to better corporate governance around the world because foreign investors are more independent than the institutional ownership of local investors. [24] found that institutional foreign investment has a positive association

with improving company values, operations performance, and investment efficiency. [25] concluded that institutional investors who own stable stakes in corporate stocks play an important role in monitoring actual earnings management practices. In general, foreign institutional investors are bold observers, and they play a dominant role in improving internal control, strengthening corporate governance, as well as influencing financing and investment decisions [10; 22; 26]. [27] found that ownership of foreign banks is associated with better cash management because of their superior monitoring skills.

Regarding the relationship between institutional foreign investment and the decision to maintain cash holdings, [28] found that Thai companies with higher foreign institutional ownership are associated with more cash holdings in 2013–2016. [10] found that foreign institutional investors have a positive impact on the excess cash holdings in a firm's value. The primary reason for this positive effect is attributed to foreign institutions residing in countries with strong governance and investor protection. Furthermore, this effect is stronger in firms less exposed to financial constraints. . On the other hand, institutional foreign investment may affect management, which leads them to invest immediately rather than retain cash to provide future financial flexibility. Therefore, it is expected that a low level of cash will be maintained as a result of increased investment in the current period. [29] found that institutional foreign investment negatively affects cash holdings by using a sample of companies in 23 countries with emerging economies. In light of the above, the researchers see that institutional foreign investment can lead to a decrease or increase in cash holdings. Also, previous studies give mixed results. Therefore, the first hypothesis can be derived as follows.

H1: There is a positive relationship between institutional foreign investment and the decision to maintain cash holdings.

Individual Foreign Investment and Cash Holdings

The concentration of ownership in the hands of a small number of foreign individuals, referred to as the main investor or the controlling shareholder, gives them the right to manage, control, and follow up the performance of senior management. Block holder may mean owning a quantity of shares or bonds that have an impact on voting rights, and it mostly refers to people who own 5% or more of the company's shares. This type of ownership, whether by local or foreign investors, is widespread in the Egyptian Stock Exchange. Some foreign individuals (particularly from the Gulf Cooperation Council countries) invest directly in buying shares of Egyptian companies so that they become the main shareholder in the company. [30] believes that there is a difference between the Arab investor and the non-Arab investor in terms of risk propensity and practical thinking. It is presented in prior literature [31–34]. There is ample evidence of the supervisory (governance) role of large individual investors, such as limiting transactions with related parties, alleviating agency conflicts, reducing corporate debt costs, and reducing financing restrictions. Moreover, the presence of foreign shareholders leads to fewer cases of institutional fraud, effective internal control, high-quality earnings information, and maximization of company value. To the best of the researchers' knowledge, there are no studies that have independently dealt with individual foreign investment and cash holdings, but rather the literature has dealt with foreign investment in general, as [35]. It is still unclear whether foreign investors contribute to improving corporate governance, thus reducing earnings management from actual activities, or whether foreigners are attracted to companies that have greater transparency in disclosing information.

The retained cash helps companies invest in profitable projects, which leads to increased confidence of foreign investors in these companies, and thus can be factors that attract large foreign shareholders to invest in these companies. [36] also found that foreign investors in the Vietnamese stock market are subject to precautionary motives and agency motive, which force firms to hold more liquidity. In addition, the study of [37] indicated that the ownership of major shareholders reduces the opportunities for administrative opportunism. [38] found that there is a negative relationship between the ownership of major shareholders and the cost of capital owned by a sample of German companies in 2006-2008. [39] found that foreign ownership in the Egyptian Stock Exchange negatively affects profit management practices, and foreign ownership can limit profit management practices whenever foreign ownership increases. Also, he found that foreign owners from Arab countries are more able than foreigners of other nationalities to limit profit management practices in Egyptian companies listed on the stock exchange. According to [40], foreign investors have a positive effect on keeping a high percentage of cash in Vietnam based on precautionary motives, which is due to the fact that the business environment in Vietnam is weak, characterized by weak investor protection, and high levels of political uncertainty and information asymmetry.

Regarding the relationship between large foreign individual investors and the decision to hold cash holdings, a foreign investor is an individual who invests a significant portion of their capital in a company, resides in Egypt, or frequently visits the country. At the same time, the foreign investor is likely to be a member of the company's board of directors, or to have a board member acting on behalf of the foreign owner. The foreign individual investor is also expected to influence management decisions. Furthermore, the foreign individual investor is likely to be more conservative regarding the risks involved in investing in a foreign company in a developing country such as Egypt. Therefore, it is expected that this positive influence will impact the company's decision to hold cash holdings. Based on the previous discussion, the second hypothesis can be derived as follows.

H2: There is a positive relationship between individual foreign investment and the decision to maintain cash holdings.

Global Depository Receipts (GDRs) and Cash Holdings

GDRs are financial instruments that can be traded in international financial markets and are issued by an international institution or bank such as Bank of New York or Deutsche Bank in US dollars or any other foreign currency traded in the free market in exchange for maintaining a corresponding cover from local stocks. According to an agreement with a local issuing company, the securities of that company are deposited with the agent of the depository bank or the issuing bank (usually a local bank) [41]. GDRs are traded as an alternative to the original securities in international financial markets such as London, New York and Luxembourg Stock Exchanges. The owner of the GDRs is, in fact, the owner of the corresponding local shares (according to an agreed conversion ratio), so the owner of the GDRs has the rights associated with those of the owner of the local shares in terms of cash and in-kind distributions and the sale of shares. There are currently two types of certificates of deposit: GDRs and American Depository Receipts (ADRs). The difference between them is that ADRs are traded in the American market, while GDRs are traded in international markets other than the American market. [42] found that the return of ADRs is more correlated with the returns of the industry in the home country than industry returns in America. This was also confirmed by [43] who found that the local factor is the most influential factor on ADR returns.

GDRs are distinguished in that they provide companies, especially companies in emerging markets, with a new source of financing for their investments, from international sources, and with a foreign currency that differs from the currency of the company's local market. This can happen without the need for a physical presence in global markets and the accompanying obstacles to direct entry into those markets [44]. In addition, investors in international markets can diversify their portfolios internationally by investing in these GDRs without resorting to direct entry into those emerging markets and the risks and obstacles that accompany direct investment in foreign markets [45]. Another advantage of the GDR system for the national economy is the launch into new markets to provide new sources of financing, and thus an increase in indirect foreign investment in Egyptian securities. As for the advantages[2] of a company issuing securities (GDRs), they are: strengthening the activities of local companies in the global financial markets and creating a presence for them, improving the process of evaluating the local stock, expanding the ownership base (internal and external markets. The issuing company also distributes profits in the local currency, but the International Deposit Bank converts those profits to the US dollar or other foreign currencies and distributes them to GDR owners. In addition, the GDRs are characterized by freedom of trading, as foreigners trade them freely in international financial markets, and the holder of certificates of deposit can sell them in the global market and recover his invested funds. He can also cancel his certificates and replace them with local stocks, which can be traded in the local market in the local currency. Therefore, the risks to which the foreign investor is exposed with international deposit certificates are significantly lower than those of the individual foreign investor or the institutional foreign investor. At the same time, the influence of the foreign investor in GDRs has a low impact on the company's management compared to large individual foreign investors or institutional foreign investors. Therefore, it is expected that there will be a negative relationship between investment in GDRs and the decision to maintain cash holdings. Thus, the third hypothesis can be derived as follows.

H3: There is a negative relationship between GDRs and the decision to maintain cash holdings.

Research Design

Data and Sample Selection

The researchers collected data manually through Annual Financial Reports (AFR), Stock Exchange Website (SEW) in Egypt, and Disclosure Report on the Board and Shareholder Structure (DRBSS) for 2014-2024. The research sample consists of all 222 joint-stock companies registered in the Egyptian stock market, of which 48 companies belong to the banking and financial services sectors, with the exception of banks, due to the presence of special features of the banking and financial services sectors, as they are subject to certain special laws. Thus, the study sample comprised 174 companies, with companies for which financial statements data and disclosure reports on the board of directors and shareholder structure were not available for 2014–2024, and companies registered in the stock exchange after 2014 also excluded. In addition, companies that merged or consolidated during the study period were excluded. during the research period were excluded, thus, the size of the research sample reached 141. The researchers specifically chose companies with participation of foreign investors, even if only for a period of one year, as well as companies that are in the EGX 30 index (the 30 most active Egyptian companies). Thus, the research sample comprised 72 companies with a total of 792 observations.

Measurement of the Variables

Dependent Variable

Our dependent variable is the cash holdings that is measured by the ratio of cash and cash equivalents to total assets [46–48].

Independent Variables

The independent variable is the components of foreign investment, which includes three variables: Firstly, Foreign corporate ownership, which is measured by the ratio of shares owned by foreign companies to the total issued

[2] URL: https://egx.com.eg/ar/GDRs.aspx

shares [24; 28]. Secondly, Foreign investor ownership, which is measured by the ratio of shares owned by individual foreign investors to the total issued shares. Thirdly, global depository receipts, measured by the percentage of shares equivalent to global depository receipts to the total issued shares.

Control Variables

The study uses several control variables that affect cash holdings and are usually used in the literature. According to many research studies [46; 48–51] there is a set of variables that affect the decision to maintain cash holdings, including the size of the company, return on assets, financial leverage, net cash flows from operating activities, the duplication of the role of the CEO, working capital, the affiliation of the external auditor with one of the major four auditing firms, earnings per share, whether the company is making losses or not, and the ratio of market value to book value. The methods for measuring each of the dependent, independent, and control variables are presented in Table 1.

Table 1. Methods for measuring different research variables

Variables	Abbreviation	Expected signal	Measurement	Source
Dependent				
Cash holdings	CASH		Cash and cash equivalents/ Total assets	AFR
Independent				
Foreign corporate ownership	FCO	-/+	The ratio of shares owned by foreign companies to the total issued shares	DRBS
Foreign investor ownership	FIO	-/+	The ratio of shares owned by individual foreign investors to the total issued shares	DRBS
Global Depository Receipts	GDR	-/+	The percentage of shares equivalent to global depository recites to the total issued shares	DRBS
Control				
Negative earnings	NEG	-	A dummy variable that equals 1 if the company achieves losses, and 0 otherwise	AFR
CEO/ chair duality	CEO	-	A dummy variable that equals 1 if the CEO is also the chairman, and 0 otherwise	DRBS
Earnings per share	EPS	+	Net profit to the number of issued shares	SEW and AFR
Firm size	SIZE	+	The natural logarithm of total assets	AFR
Net Working Capital	WC	-	(Current assets – current liabilities- cash and cash equivalents) to total assets	AFR
Firm profitability	ROA	+	Net income to total assets	AFR
Market-to-book ratio	MTB	-	The market value of investment to Total assets	SEW and AFR
Cash flow from operations	CFO	+	Cash flow from operating to total assets	AFR
Leverage	LEV	-	Total liabilities to total assets	AFR
Big four auditing firm	Big4	+	A dummy variable that equals 1 if the auditor belongs to BIG4, and 0 otherwise	AFR

Source: Created by author.

Methodology

In recent years, panel data models have gained a prominent place in financial and accounting studies. Considering that it examines the effect of change in time, and the effect of change in companies, panel data models include three types of models: Pooled Regression Model (PRM), Fixed Effects Model (FEM), and Random Effects Model (REM) [52]. To empirically test the above, the following regression models were constructed in this paper:

$$CASH_{it} = \beta_0 + \beta_1 FCO_{it} + \beta_2 FIO_{it} + \beta_3 GDR_{it} + \beta_4 CFO_{it} + \\ + \beta_5 SIZE_{it} + \beta_6 LEV_{it} + \beta_7 ROA_{it} + \beta_8 WC_{it} + \beta_9 MTB_{it} + \\ + \beta_{10} B4_{it} + \beta_{11} CEO_{it} + \beta_{12} NEG_{it} + \beta_{13} EPS_{it} + e_{it,}$$

In addition to the above, to verify the validity and credibility of the results obtained from the OLS panel data, and to ensure that our results are free from potential endogeneity issues, we re-estimate the equation used in the study using two-stage least squares (2SLS) for robustness tests. Estimates from the 2SLS are consistent and unbiased, in addition to being a simple calculation method [53–54].

Descriptive Statistics

Table 2 presents the most important descriptive statistics.

Based on Table 2, it is clear that the mean of cash holdings in Egyptian companies is 0.082, which is consistent with [38], which found that the cash-to-asset ratio ranges between 5% and 14% in developing countries. In addition, the mean of institutional foreign investment is 0.079, given that there are 27 companies with institutional foreign investment in the sample. Also, the mean of per capita foreign investment is 0.022, given that there are 13 foreign companies with per capita foreign investment in the sample. In addition, the mean percentage of GDRs is 0.021, given that there are 12 companies with GDRs in the sample.

Correlations Analysis

Table 3 presents the Variance Inflation Factor (VIF), and the correlation matrix of the research variables.

Based on Table 3, there is a negative correlation between cash holdings and both institutional foreign investment and GDRs, while there is a positive correlation between individual foreign investment and cash holdings. There is also a positive correlation between the presence of an auditor belonging to the four large accounting firms on one hand, and both institutional foreign investment and GDRs and individual foreign investment, on the other. Finally, the correlation analysis coefficients indicate the correlations among all independent variables are less than 0.8, thus it is unlikely that there is a multicollinearity problem [47]. Also, the problem of collinearity does not exist among the variables because Variance Inflation Factor (VIF), For all variables < 5 [55].

Regression Results

Table 4 shows the empirical results of the impact of foreign investment components on cash holdings. Models (1), (2), and (3) were estimated by considering the individual effects of each foreign investment component on cash holdings. Model (4) includes all foreign investment components to confirm the results of the previous three models and to take into account the fact that some firms may have all foreign investment components simultaneously.

Table 4, present the following results:

First: There is a positive, non-significant relationship between institutional foreign investment and the decision to maintain cash holdings, according to the least squares method. Therefore, the first hypothesis is rejected. The previous result can be explained by the fact that institutional foreign investment plays a role in improving the level of corporate governance and internal control, which leads to increasing the value of the company, improving its performance, and the efficiency of its investment decisions, due to the fact that institutional foreign investment is more independent than domestic institutional investment [23–25]. In addition, institutional foreign investment is linked to improved cash management due to their superior monitoring skills [27]. Foreign institutional investors promote efficient use of cash holdings [29]. In addition, by examining the institutional foreign investment data in the sample of this study, we found that the majority of institutional foreign investment is influential in making financial and administrative decisions, and that foreign institutional investment is represented on the boards of directors. Thus, the precautionary motive decreases as a safety margin against unexpected risks. The agency motive also decreases in light of institutional foreign investment, since the agency motive increases the level of cash held in companies that suffer from agency problems resulting from conflicts of interest between owners and management or between small owners and large owners, as well as since institutional investment reduces agency conflicts, and the fact that the foreign institutional investor is able to control the shareholders more effectively. However, the tax motive remains for the institutional foreign investor, as multinational companies keep cash. This is due to companies achieving profits that require the payment of high taxes in the parent company's country, and the tax rate is lower in the country in which the company resides. Therefore, these companies prefer to keep cash in the dependent country because of the low tax rate, instead of returning that money to the parent company's country and bearing the high tax burden. That is. companies convert foreign assets into cash in order to avoid the high taxes resulting from the return of foreign revenues to the parent company's country, which leads to a decrease in the tax burden [17–19]. From the foregoing, it can be said that the institutional foreign investor has reduced motives for holding cash, such as the risk hedging motive and the agency motive, but at the same time, has an increased tax motive. The previous result stated that there is no significant relationship between institutional foreign investment and the decision to hold cash because of the institutional foreign investor's conflicting motives for maintaining cash holdings.

Table 2. Descriptive Statistics

Variables	SIZE	GDR	FIO	CASH	ROA	B4	EPS	FCO	MTB	NEG	CEO	WC	CFO	LEV
Mean	8.184	0.021	0.022	0.082	0.441	0.514	0.855	0.079	1.307	0.188	0.702	2.199	0.099	0.453
Median	8.951	0.000	0.000	0.053	0.031	0.000	0.576	0.000	0.885	0.000	1.000	0.190	0.000	0.451
Maximum	11.016	1.000	0.378	14.600	0.501	1.000	9.956	0.872	13.56	1.000	1.000	3.800	1.000	2.537
Minimum	7.399	0.000	0.000	-4.510	-0.943	0.000	-11.403	0.000	0.038	0.000	0.000	-1.322	0.000	0.004
Std. Dev.	0.578	0.227	0.136	0.134	0.091	0.501	0.336	0.164	2.012	0.392	0.441	1.332	0.133	0.223

Source: Created by author.

Table 3. Descriptive statistics and Pair-wise correlation matrix

Variables	VIF	1	2	3	4	5	6	7	8	9	10	11	12	13	14
CASH 1	3.61	1													
SIZE 2	4.22	-0.065 *	1												
MTB 3	2.58	0.0103	0.0407	1											
LEV 4	2.09	-0.181***	0.368***	0.0464	1										
B4 5	3.90	-0.110 ***	0.338***	-0.0093	0.342***	1									
NEG 6	4.93	-0.192***	-0.104***	0.0311	0.086**	-0.0117	1								
FCO7	4.09	-0.074**	0.282***	0.0162	0.149***	0.258***	0.055*	1							
FIO8	4.33	0.084**	0.063*	-0.039	0.114***	0.113***	-0.029	0.360***	1						
EPS 9	3.08	0.262***	0.036	-0.111***	-0.038	-0.015	-0.442***	-0.068*	0.0419	1					
GDR 10	4.51	-0.258***	0.139***	-0.051*	0.157***	0.196***	0.071**	0.345***	0.375***	-0.049*	1				
W C 11	2.19	0.305***	-0.279***	-0.036	-0.460***	-0.274***	-0.242***	-0.220***	-0.105***	0.246***	-0.106***	1			
ROA 12	1.99	0.342***	0.029	0.009	-0.150***	-0.076**	-0.338***	-0.104***	-0.022	0.354 ***	-0.067*	0.353***	1		
CEO 13	4.60	0.071**	-0.112***	0.021	-0.192***	-0.366***	-0.081**	-0.222***	-0.154***	0.089**	-0.181***	0.197***	0.133***	1	
CFO 14	4.11	0.410***	-0.012	0.014	-0.100***	-0.037	-0.219***	-0.025	0.009	0.253***	0.038	0.126***	0.422***	0.0873**	1

Notes: *, **, *** – 10%, 5% and 1% levels, respectively.

Source: Created by author.

Table 4. Regression Results (OLS)

Variables	Model1		Model2		Model3		Model4	
	Coeff	Prob.	Coeff	Prob.	Coeff	Prob.	Coeff	Prob.
C	0.0448	0.5045	0.0408	0.5350	0.0139	0.8274	-0.0026	0.9688
FCO	0.0070	0.8293					0.0160	0.6069
FIO			0.1827	0.0027			0.3533	0.0000
GDR					-0.6459	0.0000	-0.8896	0.0000
SIZE	0.0011	0.8776	0.0009	0.8948	0.0050	0.4866	0.0062	0.3850
MTB	0.0120	0.0237	0.0130	0.0133	0.0068	0.1811	0.0010	0.6441
LEV	-0.0332	0.2118	-0.0377	0.1514	-0.0190	0.4572	-0.0170	0.4935
B4	-0.0132	0.2770	-0.0140	0.2412	-0.0057	0.6194	-0.0057	0.6167
NEG	-0.0024	0.8830	-0.0007	0.9611	0.0056	0.7218	0.0143	0.3443
EPS	0.0090	0.0151	0.0084	0.0221	0.0079	0.0250	0.0061	0.0742
WC	0.0704	0.0001	0.0739	0.0000	0.0736	0.0000	0.0809	0.0000
ROA	0.0781	0.3018	0.0870	0.2446	0.0827	0.2540	0.1075	0.1222
CEO	-0.0113	0.3232	-0.0066	0.5571	-0.0188	0.0870	-0.0135	0.2085
CFO	0.3075	0.0000	0.3025	0.0000	0.3310	0.0000	0.3382	0.0000
R-Squared		0.2729		0.2800		0.3227		0.3641
Adjusted R-Squared		0.2478		0.2552		0.2993		0.3396
Prob (F-statistic)		0.0000		0.0000		0.0000		0.0000

Source: Created by author.

Second: There is a significant positive relationship between individual foreign investment and the decision to maintain cash holdings according to the least squares method. Thus, the second hypothesis is accepted. The previous result can be explained by the fact that individual foreign investors are mostly from the Gulf Cooperation Council countries, who invest a large share of their money in the Egyptian company, and the foreign individual investor usually resides in Egypt or makes prolonged visits to Egypt. At the same time, the foreign individual investor is likely to be a member of the company's board of directors and has an influence on management decisions. The individual foreign investor is also likely to be more conservative regarding risks, since individual foreign investors are long-term investors who prefer to reinvest their profits to finance the company's long-term growth and expansion (capital gains). In addition, [40] found that foreign investors positively affect a company's retention of large cash savings in a weak business environment characterized by weak investor protection, high levels of political uncertainty, and information asymmetry. Thus, the individual foreign investor who invests a large share of his money in the company is expected to be more conservative towards risks. Therefore, it is natural that the impact on the company's decision to maintain cash holding will be positive.

Third: There is a significant negative relationship between the issuance of GDRs and cash holdings according to the least squares method. Thus, the third hypothesis is accepted. The previous result can be explained by the advantages that a foreign investor obtains by investing in GDRs. Investors in international markets can diversify their portfolios internationally by investing in GDRs without resorting to direct entry into emerging markets, with the risks and obstacles that accompany direct investment in foreign markets [45]. This allows foreign investors to diversify investments and reduce systemic risks by forming a diversified

Table 5. Regression Results (2SLS)

Variables	Model1		Model2		Model3		Model4	
	Coeff	Prob.	Coeff	Prob.	Coeff	Prob.	Coeff	Prob.
C	0.067	0.3437	0.072	0.3000	0.042	0.5315	0.035	0.7944
FCO	0.024	0.4856					0.406	0.1095
FIO			0.119	0.0714			1.377	0.0476
GDR					-0.643	0.0000	-2.563	0.0745
SIZE	-0.001	0.8460	-0.002	0.7296	0.001	0.8487	-0.004	0.8020
MTB	0.010	0.0422	0.011	0.0334	0.005	0.2849	-0.000	0.8022
LEV	-0.025	0.3646	-0.027	0.3134	-0.010	0.6964	-0.000	0.9839
B4	-0.010	0.4147	-0.011	0.3636	-0.003	0.7611	-0.008	0.6842
NEG	-0.004	0.8066	-0.003	0.8207	0.004	0.7655	0.041	0.1563
EPS	0.006	0.0993	0.006	0.1260	0.005	0.1498	0.001	0.8577
WC	0.073	0.0001	0.075	0.0001	0.076	0.0000	0.124	0.0001
ROA	0.044	0.5728	0.055	0.4831	0.047	0.5350	0.168	0.1051
CEO	-0.009	0.4462	-0.005	0.6803	-0.016	0.1627	0.002	0.9054
CFO	0.391	0.0000	0.384	0.0000	0.426	0.0000	0.356	0.0000
R-Squared		0.2019		0.2134		0.2138		0.225
Adjusted R-Squared		0.2022		0.2070		0.2093		0.211
Prob (F-statistic)		0.0000		0.0000		0.0000		0.0000
Sargan Test (P-Value)		0.2289		0.2410		0.1080		0.3283

Source: Created by author.

portfolio regionally or internationally. GDRs are also characterized by freedom of trading, as foreigners trade them freely on international stock exchanges, and the holder of GDRs can sell them on the global market and recover the invested funds. He can also cancel the GDRs and replace them with local stocks, which can be traded in the local market in the local currency. Thus, the risks to which the foreign investor is exposed in the GDRs are significantly lower compared to an individual foreign investor or an institutional foreign investor. Also, the influence of the foreign investor in GDRs has a low impact on the company's management compared to large individual foreign investors or institutional foreign investors, which allows the company's management to make various efficient investment decisions, as well as follow a positive policy to conduct regular dividend distributions to shareholders, which negatively affects the cash holdings.

Additional Tests and Robustness Check

To verify the validity and credibility of the results obtained from the OLS panel data, and to ensure that our results are free from potential endogeneity issues, we re-estimate the equation used in the study using two-stage least squares (2SLS) for robustness tests. Estimates from the 2SLS are consistent and unbiased, in addition to being a simple method in their calculations [53; 56]. Table 5 presents the result of 2SLS analysis.

Table 4 shows a correspondence in the results of the OLS regression and 2SLS. There is a positive non-significant relationship between institutional foreign investment and the decision to maintain cash holdings, according to 2SLS (Coefficient = 0.406612, sig = 0.1095 > 10%). On the other side, there is a negative and statistically significant relationship between the issuance of GDRs and cash holdings. according to 2SLS (Coefficient = -2.563360, sig = 0.0745 < 10). Also, there is a positive and statistically significant relationship between individual foreign investment and the decision to keep cash holdings according to 2SLS (Coefficient = 1.377819, sig = 0.0476 < 5).

Conclusion

Direct and indirect foreign investment plays an important role in emerging economies and financial markets, as it works to ensure liquidity and efficiency of these markets by increasing the supply of capital. Foreign investors are distinguished by their ability to help in transferring advanced modern technology and expanding the scope of experience, knowledge, and know-how available to foreign investors in terms of capabilities, competences, resources, and ability to access global markets. Also, foreign investors are from countries with high-quality governance mechanisms and laws, which enable foreign investors to monitor the company and improve its level of governance.

The study found that there is a positive relationship between individual foreign investment and the decision to retain cash holdings. This finding is consistent with [36], which found that firms with high levels of foreign ownership hold higher proportions of cash because foreign investors encourage firms to hold cash as a precaution against emergencies. Similarly, [9] found a positive relationship between foreign ownership and cash holdings for Vietnamese firms in 2007–2017.

The study also found there is a negative relationship between foreign investment in GDRs and the decision to retain cash holdings. This finding is consistent with [29], which revealed that foreign institutional ownership negatively affects cash holdings but increases the contribution of cash to firm valuation.

Furthermore, the study found there is a non-significant relationship between institutional foreign investment and the decision to retain cash holdings.

The results may help investors, financial analysts, and lenders understand the impact of the three components of foreign investment on the decision to maintain cash holdings as a risk management tool on the one hand, and as a tool to finance investment opportunities on the other hand. By identifying the components of foreign investment, investors and financial analysts can anticipate the company's cash retention policy as a source of future financing, and, accordingly, the company's dividend policy. Lenders and banks can also learn about future financing opportunities for companies and their ability to guarantee companies' repayment of their loans. Moreover, this study helps provide important information about the business environment and conditions in emerging markets, especially Egypt. This study has certain limitations. The research was limited to the time period extending from 2012 to 2022 for a sample of 72 companies. Hence, future studies could expand the study by increasing the sample size and covering a longer time period. The researchers also recommend further future studies of topics including the impact of foreign investment components on the quality of financial reports, the impact of foreign investment components on financial performance, the impact of foreign investment components on actual earnings management, the impact of foreign investment components on the cost of capital, the impact of investment components on foreign investment efficiency, the impact of foreign investment components on dividend distributions, and the factors determining returns on GDRs in the Egyptian Stock Exchange.

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The Determinants of the Capital Structure of Russian Companies against the Backdrop of Financial Turbulence: Empirical Analysis Based on Panel Data

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Abstract

The study presents the empirical analysis of capital structure determinants of Russian companies aimed at the investigation of practical applicability of theoretical approaches amid financial turbulence. Empirical estimates presented in this paper are obtained through panel data statistical analysis (panel regression); the sample comprises data covering the 2000–2022 period for 1200 companies in the non-financial sector of the national economy. When calculating the dependent variable – leverage – both market-based and balance sheet estimates are used. The results show that it is impossible to single out a unique approach to capital structure decisions since the signs of the coefficients at traditional capital structure determinants that were proven to be statistically significant in the models under consideration are consistent with both trade-off and pecking order theories. The main hypothesis of the research was confirmed: when it comes to capital structure, Russian companies follow the approach of raising debt only when internal funds become insufficient, while at the same time supporting the balance between the risk of loss of financial independence and the benefits of debt financing. To test the obtained empirical results for robustness, the models of relations between Russian companies' capital structure and the determinants under consideration were analyzed separately for crisis and pre-crisis periods. Although certain changes in regression coefficients were observed, the impact of all major determinants appeared to be consistent and not dependent on the economic cycles. Alongside traditional statistically significant determinants, exchange rate volatility was introduced. It proved to be significant at a 10% level in the fixed effects model using balance sheet estimates. Subdivision of the sample into two subsamples depending on the public status of companies rendered no substantial impact on the major capital structure determinants with the exception of debt tax shield and exchange rate volatility estimates.

Keywords: capital structure, theories of capital structure, financial leverage, emerging markets, pecking order theory, trade-off theory

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Introduction

The problem of capital structure management is one of the most significant and debatable ones in corporate finance. Academic and, now to a greater extent, scholarly literature describes in detail relevant theories that have become classical. Also, it is important to understand that the formation of capital structure in certain cases is spontaneous; subjects of financial management do not always act reasonably and in line with conceptual approaches. Consequently, empirical studies also show rather ambiguous results both for developed and emerging capital markets. Apart from internal determinants, external factors that are beyond the control of corporate management may also influence capital structure. In modern Russia, external factors comprise periodical turbulence of different types in the global financial markets, unprecedented sanctions pressure, freezing of foreign investments and currency reserves, high interest rate volatility, etc. It is necessary to conduct statistical analysis based on panel data modeling, in particular, for the impact of these factors caused by various crises in order to reveal the specific features of formation of the financing structure for Russian companies in present-day conditions.

Actually, the polemical nature of the problem does not only concern the formation of a certain ratio between equity and debt funding sources. It is also related to this issue's general relevance: practicing managers often deny that it is necessary to manage capital structure consciously, and decisions are made ad hoc. As a result, the process gets out of control because financing decisions generally take a long time and cannot be adjusted swiftly while crises and shocks arise in unpredictable ways. Besides, in imperfect capital markets (the Russian market being one of them) financing decisions are often interrelated with investment decisions and the objective of formation of shareholder value is not specified explicitly.

Overall, global and, since recently, domestic literature has accumulated a rather representative body of studies dedicated to formation of the structure of financing sources for commercial organizations. Apart from the performative acknowledgement of seminal publications, the review below emphasizes only the empirical studies relevant for this research.

The purpose of this paper is to carry out empirical analysis based on bulk data, applicability of the main capital shareholder value creation models for Russian companies in pre-crisis and crisis periods.

The paper conceptualizes the change in the classical determinants of corporate capital structure depending on the amount of leverage against the background of financial restrictions caused by macroeconomic shocks. It seems that our statistical study may make a contribution to the accumulation of empirical evidence related to the dynamics of corporate capital structure in terms of institutional specifics of the Russian market. Econometric modeling integrates the generalized analysis of micro- and macro-estimates of the capital structure factors. The authors concentrate on replicability and robustness of empirical estimates by adding a wide range of independent and control variables, mitigating the impact of the potential endogeneity problem by means of applying econometric analysis to long-term panel data.

Literature Review and Working Hypotheses

Literature dedicated to corporate finance singles out a range of approaches to the study of the issues of management of the corporate financing structure that comprise the traditional approach [1], trade-off theory [2], Modigliani-Miller theories [3; 4], pecking order theory [5; 6] and market timing theory [7]. The key objective of the theories is to explain how the decisions on raising financial resources are made and how the presence of borrowed funds influences the cost of invested capital and consequently, the current company valuation.

Research by S. Myers and L. Shyam-Sunder is one of the earliest studies that tested theories empirically [8]. According to the authors, the pecking order theory, which substantiates financing using external debt, possesses greater explanatory power than the static trade-off theory.

M. Frank and V. Goyal conducted a more extensive empirical verification of the pecking order theory [9; 10]. They analyzed two time intervals using data on 768 American companies and concluded that the theory's applicability was confirmed for the period of 1971–1989, however, for the period of 1990–1998, the pecking order theory was no longer as closely aligned with practice.

Polling of chief financial officers from 192 publicly traded British companies carried out in paper by V. Beattie, A. Goodacre and S. Thomson [11] showed that for approximately half of the respondents the target debt level, determined by balancing the financial distress costs and the tax shield, was important. At the same time, 60% of respondents said that they were prone to follow the pecking order theory when forming the capital structure and rank the degree of funding sources' attractiveness according to it. It is important that financial managers do not consider these theories mutually exclusive.

Research by A. Iqbal and O. Kume [12] studies the influence of a financial crisis on capital structure decisions. Their sample comprises 871 non-financial companies from the UK, 564 – from France and 392 – from Germany. The time interval of data spans from 2006 to 2011. In general, the results show that the financial crisis of 2007–2008 had a significant impact on companies' leverage ratios both in the market-based (UK) and bank-based economies (Germany and France).

As compared to the papers dedicated to the analysis of developed markets, present studies based on data from emerging markets are of greater relevance. Such studies need to take into consideration the impact of a range of factors that characterize the emerging financial markets. Such determinants comprise limited access to capital markets, more pronounced information asymmetry, signif-

icant agency costs and financial distress costs, as well as macroeconomic risks caused by the aggravation of the general economic situation and its constant changes.

S. Bhaduri [13] tested the dynamic pecking order theory on the basis of a sample of 363 Indian companies. According to the obtained results, growth opportunities, company size, cash flow amount, industry characteristics and the unique nature of the company may influence the choice of the optimal capital structure. S. Bhaduri [13, p. 664] points out that although the constructed five-factor model is moderately in line with data, the results are also consistent with many other existing theories of capital structure. The revealed dependence of the debt level on shortage of cash is a significant finding of the research. This supports the pecking order theory [14, p. 49].

A. Pahuja and A. Sahi [15, p. 76] put forward the assumption of simultaneous adherence to the pecking order theory and the market timing theory [15, p. 76]. The models constructed on the basis of data from the 30 largest public Indian companies for 2008–2010 confirmed the statistical significance of the impact of growth potential and liquidity level on the debt-to-equity ratio.

K. Bulent, C. Orman and A. Oduncu [16] conducted an empirical study of the determinants of the capital structure using data on 11,726 Turkish companies. Their conclusions indicate that the trade-off theory better describes the capital structure of the companies different in the size and type of activity than the pecking order theory. Apart from that, they found out that companies also take into account the median financial leverage, which is a component of the market timing theory.

Paper by C. Chang, X. Chen and G. Liao [17], based on data of Chinese companies, studied the traditional determinants of capital structure. Regression analysis of the sample of 13,107 observations for 1998–2009 revealed the significance of such factors as the profitability level, company's growth opportunities, influence of government control, industry-specific leverage, asset structure and company size at the 1% level. Thus, Chinese researchers believe that the pecking order theory prevails.

V. Nazarova and A. Budchenko [18] also studied the management of the corporate financing structure in the Chinese market. Based on the data on 57 Chinese companies and 90 firms operating in other BRICS markets for 2012–2016, the authors conclude that in view of a multidirectional impact of determinants it is not necessary to strictly follow a single classical concept of capital structure.

Particular attention should be heeded to the papers based on data about Russian companies. This will reveal the specific features of determining the factors that influence their financing structure formation. Among Russian authors, empirical analysis in the field of management of the corporate financing structure was performed by I.V. Ivashkovskaya and M.S. Solntseva [19], A.B. Ankudinov and O.V. Lebedev [20], N.A. Shakhina and M.S. Kokoreva [21] as well as other authors.

Paper by I.V. Ivashkovskaya and M.S. Solntseva [19] is one of the studies focused on empirical verification of the trade-off theory and the pecking order theory. Based on the panel data on 62 companies for 2002–2005, the authors tested the significance of such factors as profitability, asset structure, risk level, and size, and concluded that it was impossible to reject either of the considered theories and adopt a single theory that would perfectly describe the behavior of large public Russian companies when they choose sources of financing.

Research by N.A. Shakhina and M.S. Kokoreva [21] proves the applicability of the dynamic trade-off theory to be practically relevant. The theoretical approach was tested empirically using data about 56 non-financial companies for 2004–2008. According to the results, the essence of capital structure management lies in the search for the interval of optimal values of financial leverage instead of achieving its target level because, according to the dynamic trade-off theory, managers also take into consideration recapitalization expenditures along with costs and benefits of the optimal debt-to-equity ratio.

A study published in 2012 was based on the empirical verification of the capital structure factors of companies from several Russian regions [20]. The authors – A.B. Ankudinov and O.V. Lebedev – tested the key factors of financing structure formation on the basis of data from 600 non-financial companies in the Volga Federal District. The obtained results confirmed the significance of return on sales for all regions except for the Republic of Bashkortostan. The sign of the coefficient is negative, which is in line with the trade-off theory.

Paper by M. Klestov and I. Jindrichovska [22], based on regression analysis of traditional academic theories regarding the capital structure, also evaluated the statistical significance of a range of factors using data on 753 Russian and 292 Brazilian companies for 2020. The obtained results show that individual sets of determinants differ significantly in the explanatory power and produce a non-uniform effect when Russian and Brazilian companies are compared.

Decisions related to the financing structure are, first of all, premised on maximizing the companies' market value. Therefore, decisions related to the capital structure of small and medium-size publicly traded enterprises are considered quite rarely in the contemporary finance theory. Paper by N.S. Khotunova, A.I. Mikheev, E.D. Udaltsova and E.O. Ganazhukova [23] is a publication that explores the special features of capital structure management in small and medium-size enterprises. They verified the significance of classical determinants on the basis of panel data for 2019–2021 of 3,977 small and medium-sized companies. The obtained results show that size, age, profitability and asset structure are the determining factors in shaping the financing structure of Russian small and medium-sized enterprises. The signs of the variables' coefficients confirm the pecking order theory.

Empirical testing of the hypotheses describing the nature of dependence of the financial leverage level on tradi-

tional determinants during and after a financial crisis in the domestic market is assumed as a basis for research by V.V. Metel'skaya [24]. Data on 49 public joint-stock companies for 2011–2017 was used for econometric analysis. The author detected a negative dependence between the resultant debt variable and company size. This complies with the pecking order theory. Significance of macroeconomic factors included in the model was also confirmed.

E.A. Fedorova, M.O. Bakanova and E.S. Tepikina [25] raised the issue of the impact of capital structure on performance of Russian companies. The paper tested the hypothesis of a negative dependence of company profitability on debt value in the financing structure by applying regression analysis of panel data for 2020–2022. However, based on the obtained results the hypothesis was rejected – an increase in financial leverage has a positive impact on company performance.

Our review of empirical studies dedicated to capital structure management in developed and emerging markets allows us to put forward a number of hypotheses that will be tested below.

Hypothesis 1. With respect to capital structure formation, Russian companies follow the principle of attracting borrowed funds only out of need that arises as a result of insufficient internal resources. The trade-off between the risk of losing financial independence and advantages of attracting debt financing is maintained.

This hypothesis will be confirmed if the results of econometric modeling will show that enterprises follow both the trade-off and the pecking order theory.

As mentioned previously, S. Bhaduri [13], V. Beattie, A. Goodacre and S. Thomson [11], I.V. Ivashkovskaya and M.S. Solntseva [19], V. Nazarova and A. Budchenko [18], M. Klestov and I. Jindrichovska [22] obtained a similar result in their studies.

Hypothesis 2. The tax shield effect may be a factor of attracting debt financing for Russian companies.

This effect is rather strongly pronounced in jurisdictions with a high rate of income tax. However, in contemporary Russia the cause-and-effect relationship may be less pronounced.

Hypothesis 3. Industry-specific features of Russian companies' operation exert a significant impact on their financing structure.

In particular, papers by S. Bhaduri [13], A. Iqbal and O. Kume [12], K. Bulent, C. Orman and A. Oduncu [16] and C. Chang, X. Chen and G. Liao [17] analyzed the influence of this factor on the capital structure in developed and emerging markets.

Hypothesis 4. Financial crisis periods have a negative effect on the financial leverage indicators of Russian companies.

Papers by A. Iqbal and O. Kume [12] and V.V. Metel'skaya [24] studied the influence of crisis periods on the financing structure. However, they failed to get an unequivocal result because the relationship direction depends on the historically developed debt value in the capital structure.

Database, Description of Variables and Research Method

In this research, we applied standard regression analysis of panel data. An evident advantage of panel data analysis is the opportunity to expand the sample significantly by adding multiple observations for each individual component. As a result, an increase in the number of degrees of freedom and a reduction in correlation among the explanatory variables is observed. Consequently, the standard errors of the coefficient estimates are decreased. Apart from that, panel data analysis allows to trace the individual evolution of characteristic features for each individual sample component over a certain period and avoid specification errors caused by omission of significant factors in the model.

In the performed research we applied the pooled regression method, fixed effects model and random effects model.

The dependent variable is represented by the capital structure indicator, i.e., financial leverage calculated as a ratio of borrowed funds to the sum of equity and borrowed funds sources.

Literature determines two main methods for monetary evaluation of equity: the balance sheet and market estimates. The question of which estimates are the best indicators of the process of financing structure formation remains debatable to the present day. Some authors insist on the advantages of balance sheet estimates, asserting that they manifest better managers' actions related to capital structure formation while market indicators often depend on external factors beyond the company's control [14, p. 47]. According to S. Myers [26, p. 575], balance sheet estimates

Table 1. Substantive characteristics of explanatory variables

Indicator	Designation	Description of the indicator
Company size	Size	Natural logarithm of revenue
Company profitability	Profitability	Return on assets
Asset structure	Tangibility	Share of fixed assets in total assets
Company age	CompAge	Number of years since the date of state registration of the legal entity
Debt tax shield	DTShield	Ratio of current income tax to average annual assets

Indicator	Designation	Description of the indicator
Exchange rate volatility	VolatUSD	Variation coefficient of the official exchange rate of the currency pair US dollar/Russian rouble for a corresponding year
Fixed assets growth rate	FixAsGR	Ratio of the change of the book value of fixed assets for a year to their value as at the beginning of the year
Industry-specific effects	Industry_i	Dummy variables for certain types of activity: Industry_1 – extraction of commercial minerals, Industry_2 – agriculture, Industry_3 – machine building, Industry_4 – petrochemical industry, Industry_5 – metallurgical industry, Industry_6 – construction, Industry_7 – power industry, Industry_8 – wholesale and retail
Time effects	Dt_i	Dummy variable for corresponding time periods: Dt_2 – 2001 Dt_3 – 2002 etc.

allow to avoid the impact of market volatility on company value. This is especially important in emerging markets characterized by constant turbulence.

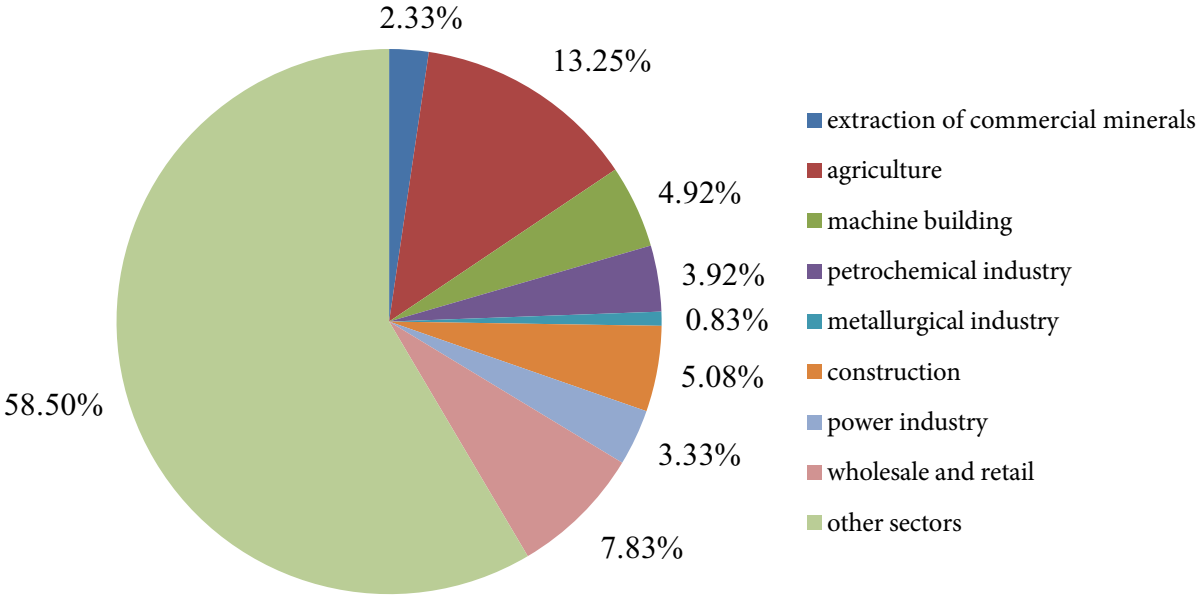
On the other hand, balance sheet estimates are indicative of past decisions while market estimates which, as stated above, are shaped under the impact of external factors, simultaneously indicating the efficiency of the current corporate financial policy.

In our research we are going to use both balance sheet and market monetary estimates of equity.

Analysis of a wide range of empirical studies allows to define some classical determinants of the capital structure. Their significance has been confirmed many times. Such determinants comprise company size and profitability, as well as the asset structure. The trade-off theory and pecking order theory interpret the nature of these factors' impact in different ways. Apart from traditional determinants, which must be present in the model, we test some other factors in this paper. Algorithms for the calculation of independent variables are presented in Table 1.

The list of independent variables is rather standard except for exchange rate volatility. The rationale behind adding this variable is as follows. In the pre-crisis period (2008), Russian companies widely used foreign-currency loans. This was driven by a quite significant foreign exchange

Figure 1. The sample structure of companies by type of activity



premium, which made borrowing substantially cheaper. Besides, a number of companies had an open foreign-currency position that could be managed only with at least a remotely predictable exchange rate. Consequently, we may presume that there is a dependence between a high volatility of the exchange rate and financial leverage.

Base regression to be tested is as follows:

$$FLev_{i,t} = \alpha + \beta_1 \cdot Size_{i,t} + \beta_2 \cdot Profit_{i,t} + \beta_3 \cdot Tang_{i,t} + \\ + \beta_4 \cdot CompAge_{i,t} + \beta_5 \cdot DTShield_{i,t} + \beta_6 \cdot Volat_{i,t} + \\ + \beta_7 \cdot FixAsGR_{i,t} + \varepsilon_{i,t}. \quad (1)$$

Later, the model will be expanded by adding new regressors: we will consider model specifications with dummy variables for the type of activity and time effects.

In the present research, we analyze a sample of data on 1,200 non-financial Russian companies in the period of 2000–2022. Data from financial statements of the analyzed companies was obtained from the SPARK reference data system. The sample structure by type of activity is presented in Figure 1.

In the course of analysis, we excluded extreme values of variables that make the sample nonuniform. In order to conduct a more detailed and high-quality evaluation of the sample, we are going to consider descriptive statistics of the variables presented in Table 2.

On the basis of the obtained data, we may make certain conclusions about the contents and structure of the sample. On average, the analyzed companies implement their financing policy in such a way that the share of borrowed funds amounts to approximately 30–40%. Some of the companies in the sample embrace a conservative financing policy, others – an aggressive financing policy when the share of debt capital amounts to 80%.

There is no strong linear relationship between the explanatory factors chosen for the model. This is confirmed by low values of pair-wise correlation coefficients. Thus, the factors may be added to the regression model without negative consequences.

When building the regression models, we decided to use (robust) standard errors consistent in the presence of heteroscedasticity because heteroscedasticity was detected in the preliminary models. It is defined as variability of error variance or variability of observations.

Analysis Results

Results of econometric modeling are presented in Table 3.

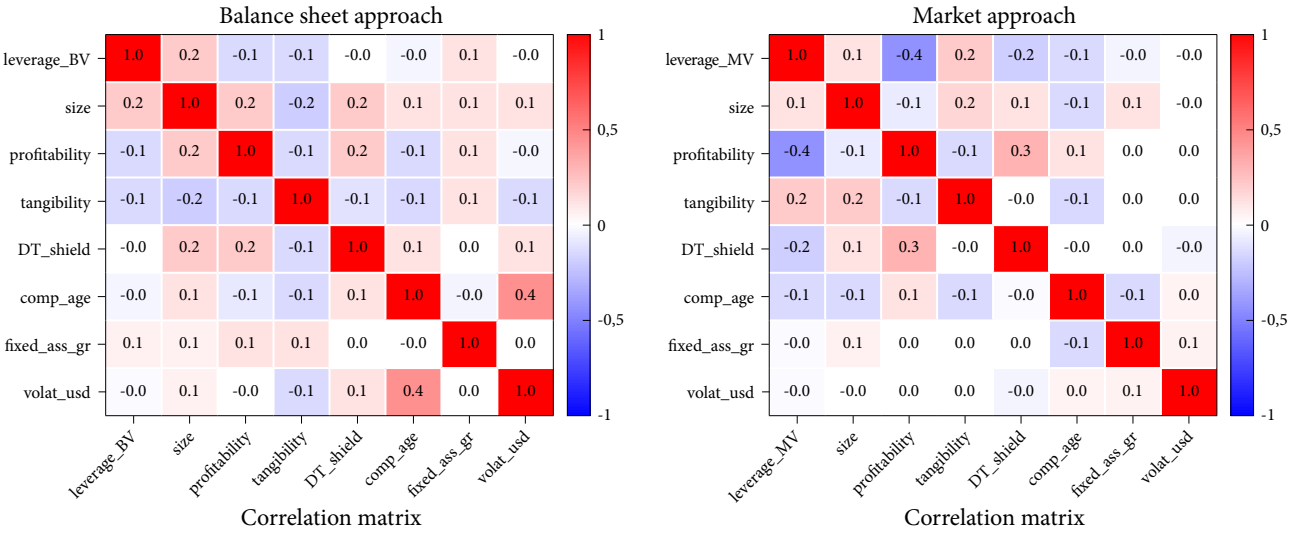
Basing on the obtained results, we can make certain conclusions. First, a positive relationship is revealed between the company size indicator and the share of debt in financing. This is consistent with the trade-off theory, which

Table 2. Descriptive statistics of variables

Variable		Observations	Mean value	Median	Standard error	Minimum value	Maximum value
FLeverage	BSA	26.610	0.3147	0.2835	0.2099	0.0000	0.8049
	MBA	577	0.3923	0.4001	0.2212	0.0001	0.8035
Size	BSA	26.541	18.4070	18.1910	2.4141	6.9078	29.7080
	MBA	577	23.9680	24.1470	2.8225	11.3500	29.7080
Profitability	BSA	26.611	0.0671	0.0387	0.1379	-0.9467	1.5892
	MBA	577	0.0955	0.0636	0.1493	-0.4108	1.3337
Tangibility	BSA	26.605	0.3979	0.3797	0.0438	0.0000	0.9997
	MBA	577	0.3529	0.3348	0.2744	0.0000	0.8972
CompAge	BSA	26.611	17	17	7.3199	0	73
	MBA	577	21.47	22.00	5.18	5.00	31.00
VolatUSD	BSA	26.611	0.0497	0.0248	0.0474	0.0127	0.1999
	MBA	577	0.0649	0.0494	0.0507	0.0182	0.1999
DTShield	BSA	21.849	0.0682	0.0111	0.2666	0.0000	9.4311
	MBA	533	0.2585	0.0703	0.6427	0.0000	6.9107
FixAsGR	BSA	26.234	0.1091	-0.0086	0.5963	-1.0000	9.9367
	MBA	568	0.1429	0.0425	0.6006	-1.0000	8.8224

Notes: BSA – balance sheet approach, MBA – market-based approach.

Figure 2. Correlation matrix of variables



Source: Made in Gretl.

states that large companies are less exposed to the risk of financial imbalance expenditures, hence, they are able to raise more borrowed funds [27; 28]. Papers by I.V. Ivashkovskaya and P.V. Makarov [14], V. Nazarova and A. Budchenko [18], N. Delcoure [29], E.V. Ilyukhin [31] also confirmed a positive impact of company size on debt level. In paper by A.B. Ankudinov and O.V. Lebedev [20], the influence of this indicator was not confirmed unambiguously. Second, negative correlation was detected between the profitability indicator and financial leverage; the coefficient significance was confirmed at the 1% level. The pecking order theory may explain this relationship: highly profitable companies have a minimal need for borrowed funds because the amount of the funds earned by the company is sufficient to finance its operations [6]. A similar result was obtained in papers by I.V. Ivashkovskaya and P.V. Makarov

Table 3. Econometric modeling results

Variable	Pooled regression	FE model	RE model
Balance sheet approach			
Constant	0.0691** (0.0426)	0.0141 (0.8107)	0.0565 (0.1846)
Company size (size)	0.0210*** (5.19e-031)	0.0252*** (2.42e-013)	0.0226*** (1.28e-021)
Profitability	-0.3492*** (1.17e-056)	-0.2395*** (5.74e-051)	-0.2465*** (2.09e-062)
Asset structure (tangibility)	-0.1533*** (4.12e-019)	-0.1868*** (1.17e-024)	-0.1830*** (9.66e-029)
Debt tax shield (dt_shield)	-0.0031 (0.6831)	-0.0198*** (0.0053)	-0.0179*** (0.0089)
Company age (comp_age)	-0.0033*** (9.13e-014)	-0.0042*** (6.59e-018)	-0.0039*** (1.37e-019)
Exchange rate volatility (volat_usd)	-0.0368 (0.2909)	0.0384* (0.0841)	0.0330 (0.1377)
Fixed assets growth rate (fixed_ass_gr)	0.0267*** (1.25e-015)	0.0216*** (1.30e-015)	0.0219*** (1.54e-016)
Number of observations	21.477	21.477	21.477
R^2	0.1182	0.5460	-

Variable	Pooled regression	FE model	RE model
Market approach			
Constant	0.2038 (0.2943)	-0.0795 (0.7464)	0.1525 (0.4615)
Company size (size)	0.0161* (0.0710)	0.0378*** (3.07e-07)	0.0225*** (0.0056)
Profitability	-0.6337*** (5.94e-09)	-0.3812*** (0.0002)	-0.3954*** (1.86e-05)
Asset structure (tangibility)	0.1513* (0.0652)	-0.1285 (0.4384)	0.0946 (0.3497)
Debt tax shield (dt_shield)	-0.0312** (0.0480)	0.0083 (0.3261)	9.69e-05 (0.9934)
Company age (comp_age)	-0.0069 (0.1711)	-0.0142** (0.0133)	-0.0114** (0.0307)
Exchange rate volatility (volat_usd)	0.0434 (0.8351)	0.0343 (0.8036)	0.0344 (0.8006)
Fixed assets growth rate (fixed_ass_gr)	0.0028 (0.9348)	-0.0385** (0.0364)	-0.0374** (0.0457)
Number of observations	278	278	278
R^2	0.2881	0.7903	-

Notes: The dependent variable is the financial leverage ratio. Standard errors consistent in the presence of heteroscedasticity are indicated in parenthesis. * significance at the 10% level; ** significance at the 5% level; *** significance at the 1% level.

[14], V. Nazarova and A. Budchenko [18], A.B. Ankudinov and O.V. Lebedev [20], N. Delcoure [29]. The significance of the asset structure determinant was also confirmed at the 1% level (balance sheet approach), however, the signs of the variable coefficient are different in two approaches. On the one hand, according to the pecking order theory, companies with a large share of tangible assets in its property structure are less exposed to information asymmetry, which causes a decrease in equity. Therefore, such companies have an opportunity to raise additional equity and will prefer to act in this way [9]. The trade-off theory explains the possibility of negative dependence between the asset structure factor and financial leverage by the fact that liquidity of tangible assets is rather limited, hence, companies with a large share of such assets may encounter a problem when selling them [27]. On the other hand, according to the trade-off theory, a large share of tangible assets contributes to a decrease in expenses related to financial distress; besides, such assets may act as a collateral when raising borrowed funds or may be sold in case of bankruptcy [28]. Positive dependence of the debt share on the asset structure is confirmed in studies by I.V. Ivashkovskaya and P.V. Makarov [14], N. Delcoure [29], which used data on companies from Eastern and Central Europe, and in paper by V. Nazarova and A. Budchenko [18], who worked with data on the Chinese market. Some other papers, in particular research by I.V. Ivashkovskaya and M.S. Solntseva [30], revealed the negative influence of the chosen factor on financial leverage of Russian companies. Thus, one can reject neither of the concepts in question, consequently, hypothesis 1 is accepted. We also may assume that the differences in the modeling results of the market-based and balance sheet approach may be related to sometimes inconsistent policy of Russian companies for revaluation of tangible assets and corresponding adjustment of liabilities. As a result, market-based and balance sheet estimates differ significantly.

Apart from classical determinants, in all three models the significance of the company age variable and the fixed assets growth rate variable was confirmed at the 1% level (the sign of dependence may change for the latter variable), and the significance of the exchange rate volatility variable – at the 10% level in the FE model when using balance sheet estimates. In this latter case, the sign between the variables is positive, which seems somewhat illogical given a lesser investors' disposition towards risk in case of financial turbulence. However, as a rule, serious fluctuations of the national currency exchange rate are generally indicative of economic crises. This may entail a rise in debt financing caused by internal resources (profit) deficiency. Overall, due to low statistical significance we cannot provide a definitive interpretation of the obtained result.

Table 4. Choosing the model specification

Balance sheet approach	F-test	Breusch-Pagan test	Hausman test
Statistics value	F(7.1194) = 68.5583	chi square(1) = 37190.6	chi square(7) = 55.98
p-value	2.97e-83	0.00	9.52e-10
Conclusion	FE > Pooled	RE > Pooled	FE > RE
Market-based approach	F-test	Breusch-Pagan test	Hausman test
Statistics value	F(7.53) = 11.5372	chi square(1) = 172.27	chi square(7) = 38.74
p-value	8.50e-09	2.36e-39	2.19e-06
Conclusion	FE > Pooled	RE > Pooled	FE > RE

According to the balance sheet approach, in the FE and RE models the statistical significance of the debt tax shield indicator was confirmed at least at the 5% level. This determinant has a negative relationship with the debt level in the capital structure. This may be due to the fact that the opportunity to use a tax shield is not the companies' pivotal motive for raising debt financing.

Specification tests were conducted in order to choose the best suited model: comparison of the fixed effects model to pooled regression, random effects model – to pooled regression and the random effects model – to the fixed effects model.

The F-test was applied to test the pooled regression model against the fixed effects model. In the second case, the Breusch-Pagan test was used. It allows to choose between the RE model and ordinary pooled regression, which disregards individual effects. The Hausman test was applied to compare two models of panel data analysis. It compares the FE model estimates obtained as a result of inter-group formation and RE model estimates obtained by the available generalized least squares method (GLS). The test results are presented in Table 4.

According to the Breusch-Pagan test results, the regression that takes into consideration fixed effects should be chosen because the null hypothesis, which holds that components are uniform, is rejected and nonuniformity of the sample is acknowledged, i.e., there is heteroscedasticity of data. According to the Hausman test, the value of asymptotic test statistics chi square exceeds the statistics critical value. The p-value for this hypothesis is less than 0.01, hence, the null hypothesis about consistency of GLS estimates is rejected at the 1% level. Thus, the FE model is chosen over the RE model.

After generalizing the results of specification tests, we may conclude that the fixed individual effect model that we have chosen is best suitable for initial data.

The sample comprises both public (according to SPARK, PJSC and OJSC) and non-public companies. Their decisions concerning capital structure management may differ in terms of company's information transparency. To verify whether the public status of an economic entity influences decisions concerning capital structure, the initial sample was divided into subsamples with public and non-public companies (Table 5).

According to the obtained results, non-public companies account for approximately 18% of the whole sample. As for the nature of the influence of all factors on the debt share, except for the debt tax shield, the results are similar to the previous ones, however, the power of influence of the determinants is different in the two groups. Such traditional factors as company size and profitability produce the strongest impact on the financing structure of public companies. These factors also influence the capital structure of non-public companies, but the power of influence is more pronounced in the first group. This is confirmed by different regression coefficients of variables. The asset structure indicator may be defined as the key factor for non-public companies. It exerts a negative impact on the capital structure, which may be due to the low liquidity of fixed assets. We also may conclude that the nature and power of influence of such factors as company age and fixed assets growth rate do not depend on whether the company is public or not, and they are the same in both groups of companies.

Significance of the exchange rate volatility in the FE model for public companies was not confirmed. Consequently, in the analyzed model, this factor has no significant influence on financing decisions. It is fair to assume that such companies are more resilient to exchange rate risks when they choose the capital structure, partly owing to the availability of a wider set of hedging instruments.

It should be noted that the debt tax shield indicator for public and non-public companies provided completely opposite estimates of regression coefficients. Besides, the significance of this factor was confirmed only for public companies; the sign of the coefficient is positive. Here we may presume that unlike non-public companies, public companies characterized in general by a higher level of

Table 5. Econometric modeling results

Variable	Pooled regression	FE model	RE model
Public companies			
Constant	0.0927*** (0.0097)	-0.0367 (0.5917)	0.0286 (0.5501)
Company size (size)	0.0189*** (5.21e-023)	0.0272*** (6.29e-012)	0.0233*** (3.39e-018)
Profitability	-0.3520*** (1.56e-049)	-0.2615*** (2.13e-047)	-0.2638*** (2.48e-057)
Asset structure (tangibility)	-0.1306*** (3.57e-012)	-0.1564*** (2.78e-016)	-0.1531*** (4.36e-018)
Debt tax shield (dt_shield)	0.0080* (0.0568)	0.0076** (0.0425)	0.0078** (0.0345)
Company age (comp_age)	-0.0028*** (3.38e-010)	-0.0041*** (2.26e-014)	-0.0038*** (4.30e-015)
Exchange rate volatility (volat_usd)	-0.0538** (0.0488)	0.0143 (0.4232)	0.0094 (0.5980)
Fixed assets growth rate (fixed_ass_gr)	0.0264*** (1.47e-015)	0.0202*** (4.00e-013)	0.0205*** (6.71e-014)
Number of observations	21.129	21.129	21.129
R^2	0.1077	0.5413	-
Non-public companies			
Constant	-0.0184 (0.8517)	0.1329 (0.1531)	0.1101 (0.1998)
Company size (size)	0.0267*** (1.08e-06)	0.0196*** (0.0003)	0.0208*** (1.25e-05)
Profitability	-0.3607*** (2.18e-019)	-0.1951*** (1.70e-012)	-0.2064*** (6.83e-016)
Asset structure (tangibility)	-0.1988*** (3.35e-08)	-0.2609*** (1.92e-011)	-0.2532*** (1.24e-013)
Debt tax shield (dt_shield)	-0.0025 (0.7972)	-0.0077 (0.3883)	-0.0076 (0.3948)
Company age (comp_age)	-0.0039*** (0.0009)	-0.0042*** (1.03e-05)	-0.0042*** (3.20e-06)
Exchange rate volatility (volat_usd)	0.0686 (0.3341)	0.0991*** (0.0043)	0.0972*** (0.0050)
Fixed assets growth rate (fixed_ass_gr)	0.0330*** (2.17e-06)	0.0260*** (8.23e-07)	0.0263*** (2.97e-07)
Number of observations	4.799	4.799	4.799
R^2	0.1520	0.5842	-

Notes: The dependent variable is the financial leverage ratio. Standard errors consistent in the presence of heteroscedasticity are presented in parenthesis. * significance at the 10% level; ** significance at the 5% level; *** significance at the 1% level.

Table 6. Econometric modeling results (crisis period)

Variable	Pooled regression	FE model	RE model
Balance sheet approach			
Constant	-0.0633 (0.1379)	0.2057*** (0.0088)	0.0745* (0.0866)
Company size (size)	0.0262*** (9.70e-031)	0.0135*** (0.0018)	0.0204*** (4.26e-019)
Profitability	-0.3235*** (4.09e-028)	-0.2455*** (2.09e-024)	-0.2631*** (3.86e-032)
Asset structure (tangibility)	-0.0783*** (0.0001)	-0.1321*** (1.40e-07)	-0.1153*** (3.31e-09)
Debt tax shield (dt_shield)	-0.0001 (0.9848)	0.0085 (0.3411)	0.0043 (0.5673)
Company age (comp_age)	-0.0030*** (2.03e-06)	-0.0041*** (2.20e-011)	-0.0039*** (3.36e-012)
Exchange rate volatility (volat_usd)	-0.0142 (0.6760)	0.0204 (0.4277)	0.0119 (0.6482)
Fixed assets growth rate (fixed_ass_gr)	0.0206*** (0.0002)	0.0204*** (5.57e-05)	0.0201*** (3.36e-05)
Number of observations	6.390	6.390	6.390
R^2	0.1138	0.6923	-
Market-based approach			
Constant	-0.2348 (0.4115)	-0.0115 (0.9673)	-0.0405 (0.8645)
Company size (size)	0.0278*** (0.0076)	0.0237*** (0.0006)	0.0224*** (0.0004)
Profitability	-0.6354*** (2.21e-08)	-0.2981*** (0.0026)	-0.3757*** (2.04e-06)
Asset structure (tangibility)	0.1172 (0.2467)	0.2372 (0.3495)	0.1923* (0.0596)
Debt tax shield (dt_shield)	-0.0421 (0.2593)	0.0021 (0.8679)	-0.0094 (0.5920)
Company age (comp_age)	-0.0012 (0.8441)	-0.0087 (0.1600)	-0.0057 (0.3027)
Exchange rate volatility (volat_usd)	0.2218 (0.2813)	0.0329 (0.7941)	0.0703 (0.5601)
Fixed assets growth rate (fixed_ass_gr)	-0.0266 (0.3786)	-0.0439*** (0.0098)	-0.0462*** (0.0016)
Number of observations	145	145	145
R^2	0.2884	0.9224	-

Note: The dependent variable is the financial leverage ratio. Standard errors consistent in the presence of heteroscedasticity are indicated in parenthesis. * significance at the 10% level; ** significance at the 5% level; *** significance at the 1% level.

financial management to one degree or another take into consideration the debt tax shield factor when making decisions on financing.

In general, the public status has failed to produce a significant impact on the main determinants of the capital structure. This result does not correspond fully to the classical provision of corporate finance about the positive impact of debt on a decrease in shareholders' monitoring expenses, maintenance of information transparency, etc. This is likely the case because the majority of companies in the sample only formally meet the publicity criteria . It appears that the result could be somewhat different if, for example, companies from the Moscow Exchange quotation list were taken into account. However, it is beyond the technological capacity of the models to take this variable into consideration (limited size of the sample for the studied number of variables). It seems to be a matter for future research.

The nature and power of influence of particular determinants may differ according to the general economic situation. In order to verify the reliability of the results obtained through empirical analysis, we are going to consider the models of dependence of the financing structure of Russian companies on the chosen factors in crisis and pre-crisis periods.

We decided to add to the crisis period sample the following time intervals that were identified based on structural breaks in the Russian economy: 2008–2009 (global financial crisis), 2014–2016 (sanctions crisis and a collapse in oil prices), 2020–2021 (COVID-19 pandemic) and 2022 (geopolitical crisis). The results of modeling are presented in Table 6.

Time intervals of 2000–2007, 2010–2013 and 2017–2019, which are not considered crisis periods, represent the period of steady growth and are added to the pre-crisis sample (Table 7).

According to the results presented in Tables 6 and 7, there are significant changes in the power of influence of a series of factors, in particular, company size, asset structure and debt tax shield.

In accordance with the balance sheet and market-based approaches, both in the crisis and pre-crisis periods, the significance of the company size variable was confirmed at the 1% level in the FE model. However, the power of the positive relationship between the variables in the crisis period is twice as low as in the pre-crisis period. This indicates that the advantages of a large company size lessen during an economic crisis.

The statistical significance of the asset structure factor was confirmed at the 1% level both in the crisis and pre-crisis periods, however, the power of dependence is different. According to the FE model, the regression coefficient for this factor in the crisis period is 1.5 times lower than in the pre-crisis period. We may presume that in a stable pe-

Table 7. Econometric modeling results (pre-crisis period)

Variable	Pooled regression	FE model	RE model
Balance sheet approach			
Constant	0.1402*** (4.51e-05)	-0.0253 (0.6905)	0.0735* (0.0718)
Company size (size)	0.0184*** (1.84e-024)	0.0282*** (4.24e-014)	0.0223*** (3.44e-023)
Profitability	-0.3686*** (1.14e-056)	-0.2318*** (3.73e-035)	-0.2439*** (1.73e-044)
Asset structure (tangibility)	-0.1929*** (3.56e-028)	-0.2075*** (2.48e-027)	-0.2049*** (1.82e-034)
Debt tax shield (dt_shield)	-0.0090 (0.4281)	-0.0381*** (0.0047)	-0.0332*** (0.0099)
Company age (comp_age)	-0.0033*** (1.58e-012)	-0.0045*** (1.39e-016)	-0.0040*** (7.25e-018)
Exchange rate volatility (volat_usd)	-0.2390** (0.0385)	-0.0296 (0.6774)	-0.0502 (0.4844)
Fixed assets growth rate (fixed_ass_gr)	0.0294*** (1.86e-012)	0.0211*** (2.27e-011)	0.0219*** (3.22e-012)
Number of observationss	15.087	15.087	15.087
R^2	0.1262	0.5599	-

Variable	Pooled regression	FE model	RE model
Market-based			
Constant	0.5110** (0.0189)	-0.5909 (0.1674)	0.3571 (0.1901)
Company size (size)	0.0051 (0.6222)	0.0603*** (0.0001)	0.0125 (0.3302)
Profitability	-0.6913*** (2.37e-06)	-0.5555*** (8.52e-05)	-0.5952*** (1.08e-06)
Asset structure (tangibility)	0.1584** (0.0387)	-0.0653 (0.7945)	0.1466* (0.0673)
Debt tax shield (dt_shield)	-0.0362** (0.0430)	0.0015 (0.9272)	-0.0137 (0.2931)
Company age (comp_age)	-0.0099 (0.1248)	-0.0152* (0.0923)	-0.0105 (0.1676)
Exchange rate volatility (volat_usd)	0.9885** (0.0312)	0.4474 (0.2551)	0.5989* (0.0925)
Fixed assets growth rate (fixed_ass_gr)	0.1281* (0.0905)	-0.0355 (0.7182)	0.0156 (0.8381)
Number of observations	133	133	133
R^2	0.3602	0.8026	-

Notes: The dependent variable is the financial leverage ratio. Standard errors consistent in the presence of heteroscedasticity are indicated in parenthesis.* significance at the 10% level;** significance at the 5% level; *** significance at the 1% level.

riod the asset structure is one of the key factors of financing structure management and is indicative of the strategic decisions and operation flexibility, while in a crisis period companies turn their attention to survival at the moment and current liquidity. Apart from that, crisis may temporarily break down relationships. For this reason, the asset structure that was optimal in a pre-crisis period may become burdensome, or its influence may be mediated by the aggravated problems.

Significance of the debt tax shield variable in the FE model was confirmed at the 1% level with a regression coefficient of -0.0198. In the pre-crisis model, according to the balance sheet approach, the significance of the determinant was also confirmed at the 1% level with a regression coefficient of -0.0381. In the pre-crisis period, the factor is insignificant. This result indicates that benefits from debt tax shield during a crisis period become irrelevant or minimal because of increasing unprofitability of business. It should also be noted that in the crisis period access to borrowed funds is limited sharply as credit terms are tightened. Consequently, high costs of debt may negate the net benefit of tax shield.

It is important to note that in the models for the balance sheet approach, statistical significance and level of relationship with such factors as profitability, company age, exchange rate volatility and fixed assets growth rate have not changed significantly in the course of transition from the pre-crisis period to the crisis period. According to the balance sheet approach, the regression coefficients are statistically significant at a comparable level in FE models for both periods. Thus, the relationship between these factors with the resultant indicator is stable and does not depend on the economic cycle phase (Table 8).

The results obtained earlier were confirmed in the models constructed by means of adding new variables. Traditional capital structure determinants influence financial leverage, at the same time variable coefficient signs prevent us from making an unambiguous conclusion and, thus, choose one of the theories. Significance of dummy variables for certain types of activity was confirmed at the 1%, 5% or 10% levels. In particular, in the balance sheet approach, the positive impact of the type of activity factor was confirmed for companies involved in wholesale and retail and construction, and the negative impact – for agricultural enterprises. It should be acknowledged that it is currently impossible to explain the obtained results concerning the type of activity variable in complete detail. Reasoning from this fact, hypothesis 3 is rejected with a certain degree of conditionality.

Paper by E.V. Ilyukhin [31] also confirms the significance of industry specifics. In particular, it was discovered that the debt share in the financing structure of oil and gas, as well as steel, companies is lower than that of companies involved in other activities.

Table 8. Econometric modeling results with the type of activity as the dummy variable

Variable	Pooled regression	FE model	RE model
Balance sheet approach			
Constant	0.0604* (0.0974)	0.0141 (0.8107)	0.0515 (0.2468)
Company size (size)	0.0208*** (2.24e-026)	0.0252*** (2.42e-013)	0.0227*** (6.67e-020)
Profitability	-0.3356*** (8.11e-055)	-0.2395*** (5.74e-051)	-0.2455*** (1.20e-061)
Asset structure (tangibility)	-0.1382*** (1.03e-015)	-0.1868*** (1.17e-024)	-0.1809*** (1.02e-027)
Debt tax shield (dt_shield)	-0.0065 (0.4059)	-0.0198*** (0.0053)	-0.0182*** (0.0081)
Company age (comp_age)	-0.0032*** (1.07e-012)	-0.0042*** (6.59e-018)	-0.0039*** (2.68e-019)
Exchange rate volatility (volat_usd)	-0.0255 (0.4670)	0.0384* (0.0841)	0.0333 (0.1348)
Fixed assets growth rate (fixed_ass_gr)	0.0261*** (5.15e-015)	0.0216*** (1.30e-015)	0.0218*** (2.33e-016)
Dummy variable – extraction of commercial minerals (industry_1)	-0.0119 (0.6539)	-	-0.0310 (0.3259)
Dummy variable – agriculture (industry_2)	-0.0264** (0.0224)	-	-0.0263** (0.0258)
Dummy variable – machine building (industry_3)	0.0116 (0.5491)	-	0.0077 (0.6853)
Dummy variable – petrochemical industry (industry_4)	0.0186 (0.4178)	-	0.0065 (0.7723)
Dummy variable – metallurgical industry (industry_5)	0.0314 (0.5077)	-	-0.0176 (0.7254)
Dummy variable – construction (industry_6)	0.0466** (0.0181)	-	0.0468** (0.0149)
Dummy variable – power industry (industry_7)	0.0143 (0.5355)	-	0.0025 (0.9197)
Dummy variable – wholesale and retail (industry_8)	0.0376** (0.0164)	-	0.0306* (0.0513)
Number of observations	21.477	21.477	21.477
R^2	0.1257	0.5460	-
Market-based approach			
Constant	0.2975 (0.1699)	-0.0795 (0.7464)	0.1597 (0.4789)
Company size (size)	0.0148 (0.1225)	0.0378*** (3.07e-07)	0.0223*** (0.0075)
Profitability	-0.6226*** (3.30e-010)	-0.3812*** (0.0002)	-0.4130*** (8.21e-06)
Asset structure (tangibility)	-0.0611 (0.5071)	-0.1285 (0.4384)	-0.0869 (0.3700)
Debt tax shield (dt_shield)	-0.0159 (0.3716)	0.0083 (0.3261)	0.0008 (0.9482)

Variable	Pooled regression	FE model	RE model
Market-based approach			
Company age (comp_age)	-0.0104** (0.0291)	-0.0142** (0.0133)	-0.0125** (0.0152)
Exchange rate volatility (volat_usd)	0.0814 (0.6578)	0.0343 (0.8036)	0.0748 (0.5967)
Fixed assets growth rate (fixed_ass_gr)	-0.0045 (0.8948)	-0.0385** (0.0364)	-0.0368* (0.0580)
Dummy variable – extraction of commercial minerals (industry_1)	0.0220 (0.7385)	-	-0.0008 (0.9926)
Dummy variable – machine building (industry_3)	0.1330 (0.3108)	-	0.1655 (0.1455)
Dummy variable – petrochemical industry (industry_4)	0.2006*** (0.0048)	-	0.2041** (0.0165)
Dummy variable – metallurgical industry (industry_5)	0.0599 (0.3667)	-	0.0459 (0.5550)
Dummy variable – construction (industry_6)	0.0326 (0.4477)	-	0.0335 (0.4732)
Dummy variable – power industry (industry_7)	0.2804*** (3.16e-05)	-	0.2879*** (2.89e-05)
Dummy variable – wholesale and retail (industry_8)	0.0768 (0.2361)	-	-0.0259 (0.8088)
Number of observations	278	278	278
R^2	0.4052	0.7903	-

Notes: The dependent variable is the financial leverage ratio. Standard errors consistent in the presence of heteroscedasticity are indicated in parenthesis.* significance at the 10% level;** significance at the 5% level; *** significance at the 1% level.

In order to test hypothesis 4, we built models with dummy variables. In the balance sheet approach the time period spans 2000–2022, in the market-based approach – 2011–2022. The results show that in the RE model with the balance sheet approach, the significance of the coefficients of time variables responsible for 2002, 2008, 2010–2013 and 2015–2021 was confirmed.

In the market-based approach, the time variables had no statistical significance. The obtained results confirm that, unlike the balance sheet approach, application of the market-based approach to evaluation of company equity allows to take into consideration the consequences of financial crises and their impact on the companies and their financing structures. Signs of the variables were positive, thus, we cannot accept hypothesis 4.

Main Conclusions, Possible Limitations of the Analysis and Future Research Avenues

The main result of our analysis is the confirmation of the first hypothesis. At the same time, it is impossible to make an unambiguous conclusion and choose one of the theories because there are components of both approaches – the trade-off theory and pecking order theory.

A wide range of stakeholders may use the research results: corporate managers – in order to shape policy related to the capital structure, liquidity management and financing planning; banks and institutional investors – to conduct proactive underwriting, price formation and stress-testing

practices; analytical organizations – to refine factor models and early warning systems; regulators (Bank of Russia, Ministry of Finance, public markets) – to substantiate the requirements to information disclosure, develop the local debt market.

It is necessary to point out some limitations of analysis. Since some of the studied companies are non-public, it is difficult to consider the line of reasoning from the point of view of information asymmetry between insiders and outsiders unequivocally relevant. It is more likely that in contemporary Russia (even more so in the current circumstances of extremely high cost of borrowed funds), corporate management relies on internal financing sources as much as possible. Apart from that, it should be noted that certain companies have an opportunity to obtain credits on non-market terms or against government guarantee. As a result, the capital structure is distorted significantly, which skews it towards higher leverage.

From the technical point of view, it is necessary to acknowledge a certain limitation of the sample size, specifically, for the number of studied variables. Hopefully this limitation will be eliminated in the future as data is accumulated.

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Does the External Institutional Environment Impact Corporate Capital Structure? Evidence from Emerging Economies

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Abstract

The relevance of the article stems from the lack of definitive conclusions about the influence of the external institutional environment on the speed of adjustment (SOA) to target capital structure in emerging economies. We assess the external institutional environment by the quality of law and the quality of law enforcement. We then explore the impact of external institutional environment on the SOA to target leverage for companies from emerging economies. We employ a linear partial adjustment model with fixed company effects, estimated using the Blundell-Bond method. The dataset includes 2,729 firms from 17 emerging economies over the period of 2010–2019. The value of SOA to target leverage is calculated for each country from the sample, taking into account the external institutional environment. A positive effect of law enforcement on the SOA of companies is revealed, although this influence is weak. Furthermore, grouping countries by the quality of the external institutional environment allows us to show that countries with the "best" institutions have a higher SOA than countries with the "worst" institutions for most indicators of external institutional environment quality. The final results provide empirical confirmation of the significant influence of law enforcement and of most indicators of law quality on the SOA of companies in emerging economies, which has not been proven previously in the scientific literature.

Keywords: emerging markets, external institutional environment, institutions, company capital structure, speed of adjustment to company target capital structure

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Introduction

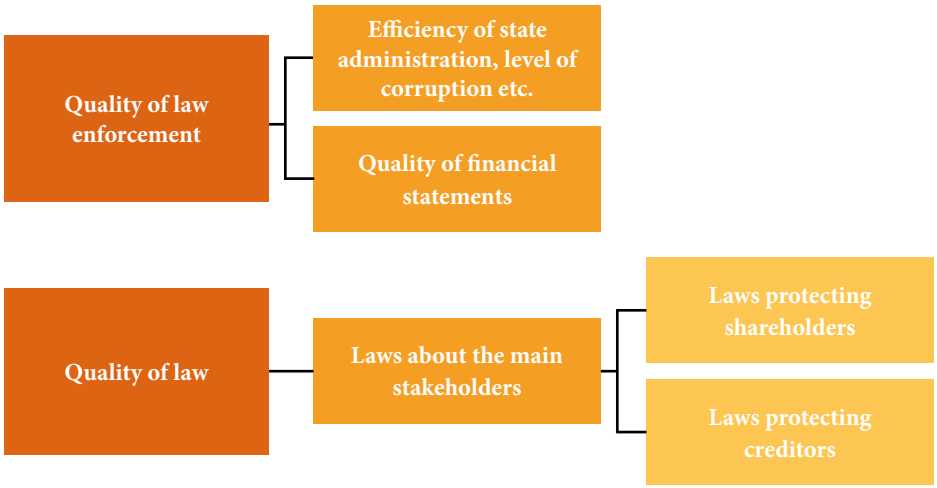
Since the appearance of the paper by S. Myers [1] describing how companies determine their target capital structure, a large number of different publications have appeared on this topic. First, scientists focused on the capital structure of companies from the world's major economies, such as the USA and the United Kingdom. Then, researchers expanded their geographical samples to study emerging countries [2], Asian economies [3] and countries from other regions [4]. It should be noted that such papers usually point out both company-specific characteristics of capital structure management and country-specific factors. At some point, economists drew attention to the external institutional environment as an important country-specific factor. In this paper, we shall study the impact of external institutions on the corporate capital structure.

The external institutional environment is shaped by a country's social, political and legal rules, which influence both physical persons and companies. Political and social rules are rather difficult to measure while legal rules are set down in documents. Some researchers argue that the main legislative factors determining the influence of the external institutional environment on corporate economic development is the efficiency of shareholder and creditor protection [5–7]. Many economists believe that the quality of law enforcement is even more important than the content of these laws.

One may divide the external institutional aspects mentioned above into two subgroups: quality of law and quality of law enforcement (Figure 1).

So, why is quality of law and quality of law enforcement capable of influencing the SOA of capital? The positive relation between these parameters and SOA stems, first and foremost, from reduced transaction expenses, i.e., the expenses incurred for adjusting to a certain target capital structure [8]. In a high-quality external institutional environment, investors are sure that their funds will be repaid and that a company will not behave opportunistically, evading its commitment of paying interest or dividends. Besides, the cost of obtaining funds from investors is not so high as in an economy with a less developed institutional environment, because investors do not charge a risk premium and other possible incremental costs needed for monitoring company operations. Consequently, as shown in [9; 10], a company can raise funds in the debt or stock market with lower expenses and within a shorter period.

Figure 1. Classification of aspects influencing institutions in a country



Source: compiled by the authors on the basis of literature analysis.

The first studies which considered the influence of the external institutional environment on the corporate capital structure appeared in the late 20th century. R. Rajan and L. Zingales analysed seven advanced economies to demonstrate that the corporate capital structure is affected not just by company-specific characteristics, but also by certain country-specific factors such as accounting standards, special features of the tax system, and bankruptcy regulations [11]. Later, A. Demirguc-Kunt and V. Maksimovic analysed a larger sample of developed and emerging countries and showed that differences in the level of long-term debt of companies in these two groups of countries depended on the efficiency of the legal system, the maturity of the securities market, the state of the banking sector, and the amount of government subsidies [12]. Nevertheless, this study considered a limited number of emerging countries (only 11). One aspect of the authors' approach was later used in other studies. The authors employed the share of long-term debt in company capital as a dependent variable measuring the capital structure of companies. Favourable institutional conditions encourage companies to prefer long-term over short-term capital. As a result, later studies in this field began to assess the influence of the institutional environment on the share of long-term debt.

In 2006, J. Fan and co-authors studied the differences in the corporate capital structure between two groups of countries: developed and emerging ones. They also used a more extensive sample comprising 39 countries. They uncovered a significant relationship between country characteristics (legal and tax systems, level of corruption, maturity of the securities market, legislative framework for bankruptcy regulation) and company leverage. For example, they showed that, in more corrupt countries, companies tend to use short-term debt while, in a more protected legal environment, the share of long-term borrowed funds and equity in company capital structure is higher [13]. Long-term debt is of great importance for implementing company strategy, including investment projects, mergers and acquisitions.

After 2010, the number of regional studies dedicated to the external institutional environment and capital structure increased. B. Awartani et al. studied the structure of debt obligations and its company-specific and institutional factors (mainly law enforcement factors) using a sample of Middle East and North Africa (MENA) countries. They came to the conclusion that such countries make considerable use of long-term debt and have relatively well-developed external institutions [14]. Ö. Öztekin and M. Flannery, in their turn, considered the influence of the institutional environment (factors of the legal system, the level of creditor and shareholder protection) on the SOA to the target capital structure, analysing a mixed sample of developed and emerging countries. It should be said that, once again, their sample comprised only a limited number of emerging countries. The authors showed that institutions have a significant impact on the expenses of adjustment to the target capital structure, hence, on the SOA to the target capital structure [8].

The paper by B. Matemilola et al. [10] is one of the most recent studies on this topic. The authors consider the influence of the institutional environment on the SOA to the target capital structure of companies only in emerging countries. Nevertheless, the authors evaluated only a limited number of factors determining the institutional environment, employing just six indicators from the Worldwide Governance Indicators database of the World Bank. They showed that institutions influence the capital structure of companies in Latin American, Eastern European and Asian countries, while no such relationship exists in Africa.

S. Makarova and K. Merkulov conducted a detailed study of the influence of the external institutional environment on the capital structure of Russian companies using a sample of 72 Russian firms for 2007–2011 [15]. The authors established that such indicators of the external institutional environment as the improved protection of creditor rights, the greater independence of the judicial system, and the positive subjective perception of corruption drive long-term debt up in the capital structure of Russian companies. At the same time, the level of property rights protection is related negatively to the long-term debt of Russian companies. According to the authors, the reason is that the effective protection of property rights encourages shareholders to provide equity. As a result, the debt load in the financing structure decreases. However, these findings are true only for Russia and are not applicable to other emerging economies.

Nevertheless, the positive impact of the legal environment for creditors on the amount of long-term funds provided by them is not proven by all empirical studies. For example, L. Booth et al. detected only a weak relationship between an external institutional environment favourable to creditors and the share of long-term debt in the total debt of companies [2]. Other prominent researchers found such a relationship only in developed countries, not emerging ones [12].

It should be noted that companies often avoid using long-term borrowed funds to finance their operations if they realize that they will find themselves in a less favourable position than their creditors. Under such circumstances, companies may prefer to use their own funds for financing. A company's decision not to use long-term borrowed funds may be a manifestation of its market power, i.e., its independence from creditors' funds even if the institutional environment for borrowing funds improves and debt becomes cheaper [15]. Therefore, it is difficult to predict how an institutional environment favourable to creditors will affect the corporate capital structure (the share of long-term debt to total debt).

We use a sample of 2,729 companies from 17 emerging countries for the period from 2010 to 2019 to study the nature of influence of two groups of factors which are indicative of the external institutional environment of companies. One group relates to law enforcement, and the second one to quality of law. These factors cannot be considered separately. Indeed, high-quality law increases the number of transactions, including credits [11]. At the same time, the existence of a law enforcement system is an essential aspect of the institutional environment for companies [7; 8; 16]. To the best of our knowledge, the only publication to consider both quality of law and quality of law enforcement is the paper by Flannery and Öztekin [8]. Nevertheless, these authors use the assessments of other scholars as proxy variables although such assessments are often out of date. The quality of law and law enforcement can have a significant impact on the rapidity with which companies attain their target level of capital structure. However, scholars hold different views on the influence of these determinants on the SOA to the target capital structure of companies, and there is no empirical estimate of the nature of their influence. This explains the importance of the present research.

Furthermore, this is the first paper to study this problem for a sample consisting exclusively of countries with emerging markets (in addition, the choice of countries is justified in contrast to many other studies). It should be highlighted that this article examines countries similar to Russia from the point of view of market maturity. Although researchers have previously included emerging countries in their papers [8; 14], this study uses the largest sample of countries with emerging markets in the literature. As a result, we as-

sess the impact of the factors of the external institutional environment on the target capital structure in a more comprehensive and accurate manner than previous studies. Existing publications have failed to assess the influence of the full scope of factors indicative of both the quality of law enforcement and the quality of the laws themselves in protecting shareholder and creditor rights.

A sample of 2,729 companies from 17 countries for 2010–2019 allowed us to obtain new results.

First, we calculated for the first time the speed of adjustment to the target capital structure of companies for each emerging market economy, taking the quality of law enforcement into account. In particular, for Russia, this factor exerts a significantly positive impact on the capital structure of companies at the 1% level (calculated as the ratio of long-term and short-term debt to the capital market value) while the SOA of Russian companies is 0.215. On the basis of the obtained SOA values across countries, we established that the higher the quality of law enforcement, the greater the overall speed of adjustment to the target capital structure. It should be noted that, although this relationship is clearly observable, it is quite weak on the whole.

Second, dividing the entire sample of countries into three subgroups based on the quality of law enforcement (the first group with the highest indicators, the second one with average indicators, and the third group with the lowest ones) led to the following new results. The SOA for the first and second subgroups are higher (29.2 and 42.8%, respectively) than for the third subgroup, where the SOA did not exceed 16%. Thus, empirical research proves that the quality of law enforcement has a significant impact on the speed of adjustment to the target capital structure of companies from emerging markets.

Third, quality of law was used to analyse the second group of indicators that evaluate the state of the external institutional environment. To this end, the sample of 17 countries was divided into three subsamples based on indicators of the protection of shareholder and creditor rights. This section of the research provided the following new results. It was shown that higher indicators of the rate of repayment to creditors in case of bankruptcy, the degree of managerial responsibility and the level of protection of minority shareholder rights lead to higher company SOA. For this parameter, the group with the "best" institutions has the highest speed of adjustment, the group with "average" institutions exhibits moderate speed while the group with the "worst" institutions is the slowest one. In the groups with the "best" and "worst" institutions, dependence was confirmed for the indicators of the amount of fund recovery by creditors, the depth of credit information about borrowers, and the legal strength index. For each of these indicators, the SOA is always higher in the group with the "best" institutions than in the group with the "worst" institutions. Apart from that, the expenses for fund recovery by creditors in case of bankruptcy (bankruptcy expenses) was revealed to have a clearly negative impact.

In the subsequent sections of the paper, we put forward the key hypotheses of our empirical research, substantiate the choice of research methods, and describe the sample of countries and companies. Finally, the empirical research results and their interpretation are presented along with conclusions.

Research Hypotheses

Now let us substantiate our hypotheses about the impact of the external institutional environment on the SOA to the target structure of capital of companies from emerging markets. As previously stated, we evaluate the quality of the external institutional environment on the basis of two groups of factors: quality of law enforcement and quality of law in a given country.

First, we consider the first group of factors to generate hypotheses about their influence on the company capital structure. The best-known and most widely used indicators of quality of law enforcement are the data published by the World Bank in the Worldwide Governance Indicators (WGI) database [17]. The sources for indicators of governance quality comprise surveys of companies and households (for example, the Global Competitiveness Report of the World Economic Forum), assessments of commercial agencies and mass media (for example, *Global Insight*) [18], assessments of non-governmental institutions (*Reporters Without Borders*), various other organizations (such as the *European Bank for Reconstruction and Development*) [19] and public sector organizations (for example, the *French Ministry of Finance*). In all, about 30 different sources are used to compile WGI indicators [20]. Similar indicators have been used by a number of other authors, including M. Belkhir et al. [21].

Proxy indicators of law enforcement are indicative of governance efficiency (Figure 1). They are divided into three main groups, with two indicators in each.

The first group of indicators describes the processes of electing, monitoring, and rotating the government and government officials. The first indicator in the group is Voice and Accountability to society. This indicator shows whether people consider elections of the head of state and government bodies to be honest and fair and whether the printed media are free. The second indicator is Political Stability and Absence of Violence/Terrorism, which measures citizens' perception of the probability of government destabilization.

The second group of indicators provides insight into the state's ability to introduce effective reforms. The first indicator of this group is Government Effectiveness. It gives an idea of how people assess the quality of public services. The second indicator is Regulatory Quality. It is focused on the state's ability to develop and introduce reforms which foster the rapid development of the private sector.

The third group of indicators is centred on the respect of the citizens and the state for the institutions regulating economic and social interaction between them. This group comprises the Rule of Law indicator. It shows the degree of confidence among economic operators that society respects and complies with the law. The final indicator in this group is Control of Corruption. It assesses

people's perception of the existence of corruption at the state level.

Thus, in the present paper six indicators from the World Governance Indicators database compiled by the World Bank are used as proxy variables for the factors of the external institutional environment relating to law enforcement. Their values range from –2.5 to 2.5. To avoid multicollinearity, we shall compile an aggregate index on the basis of these six indicators.

It should be noted that we decided to exclude financial statement quality from the set of indicators describing law enforcement in our research.[1]

This leads to our first hypothesis.

Hypothesis 1. The higher the quality of law enforcement in a country, the faster the speed of adjustment to the target capital structure of companies.

Now let us justify the choice of proxy variables for measuring the quality of law. As stated above, the main legislative factors that determine the influence of the external institutional environment on the economic development of companies are the quality of shareholder and creditor protection [5–7].

In line with World Bank methodology, we added three factors to the first group of determinants indicative of the quality of laws protecting creditors. They are related to the probability of fund recovery in case of bankruptcy and are published in the Doing Business database of the World Bank. The first factor is the time period within which creditors can recover their funds in the event of borrower bankruptcy. The second factor is bankruptcy expenses, which are indicative of the amount of funds necessary to cover court proceedings and other services related to the bankruptcy procedure. The third factor is the amount of debt recovery in case of bankruptcy. This value is equal to the amount of cents per dollar which the borrower must repay. For creditors, it is important to understand the probability of recuperating the debt financing of a company. Creditors consider the high probability of recovery to be a favourable feature of the external institutional environment. In such a case, they are more willing to grant companies long-term financing. Apart from that, companies do not incur high expenses to attract debt capital because the offer of funds by creditors is high.

This leads to hypothesis 2.

Hypothesis 2. The better the national legislation protecting creditors in a bankruptcy procedure, the higher the speed of adjustment to the target capital structure of companies.

It is of great importance that laws vest rights in creditors to collect the necessary information about borrowers so as to protect themselves. Therefore, the second group of factors indicative of the quality of laws protecting creditors' rights comprises the legal strength index of investors (borrowers and creditors) and the depth of the information disclosed by borrowers to creditors. This data was also obtained from the Doing Business database of the World Bank. The legal strength index determines the extent to which laws in a certain country facilitate obtaining and granting loans. The depth of information for creditors shows the coverage and scope of information about a company's creditworthiness as well as the availability of such information. In general, well-designed laws protecting creditors reduce information asymmetry between creditor and borrower, decreasing the creditor's transaction expenses. In such circumstances, creditors do not have to make significant efforts to mitigate risks because, in an environment favourable to creditors, their rights are already secured at a high level. This leads to the following hypothesis.

Hypothesis 3. The better the national legislation protecting creditors when granting credits, the higher the speed of adjustment to the target capital structure of companies.

Now we proceed to the quality of laws protecting shareholders. According to the World Bank's position, represented by indicators from the Doing Business database which were used by S. Djankov et al. [22], the protection of minority investor rights and the extent of the managerial responsibility are indicators of the quality of the external institutional environment from the standpoint of shareholders. Both indices measure the impact investors can produce on a company, including their ability to influence the management's decisions. This allows us to formulate our fourth hypothesis.

Hypothesis 4. The better the national legislation protecting shareholder rights, the higher the speed of adjustment to the target capital structure of companies.

Similar hypotheses have been advanced by several other authors. R. La Porta et al. were among the first to assess differences between developed countries by institutional characteristics (creditor and shareholder rights) [5]. Also, some researchers showed the impact of the development of the debt and stock markets (which may potentially be a result of the protection of creditor and shareholder rights) on financial and economic indicators such as economic growth and the expansion of capital-intensive sectors [11; 23]. Later, A. Demirguc-Kunt and V. Maksimovic advanced and substantiated similar hypotheses to those of the present study, describing the influence of creditor and shareholder rights on the capital structure of companies. In particular, they showed that, in more developed countries that obviously have more advanced institutions, the share of long-term capital in the total borrowed funds of companies is greater [12]. Nevertheless, scholars have explored the impact of the external institutional environment first and foremost on the share of long-term funds

[1] The financial statements of large publicly traded companies are prepared on the basis of uniform international standards. Each country may have its own principles of financial accounting and preparing reports. However, due to the growing globalization and the free flow of capital from one country to another, uniform international standards are used extensively. They are understandable for market participants in any geographic location. The principles used in IFRS are applied in a coordinated and combined fashion. Publicly traded companies in emerging economies have to publish their financial statements according to IFRS or US GAAP [5]. For these reasons, the quality of financial statements may be insignificant for such companies.

in the company capital. In our study, we premise on the assumption that, if in better institutional conditions companies can raise long-term capital in an easier way, their speed of adjustment to the target structure will probably also be higher. This may be due to the fact that companies can change their capital structure quickly, when necessary, by obtaining debt capital from the stock or debt markets.

Research Methodology

Today, most researchers use the linear partial adjustment model to measure the speed of adjustment to the target capital structure, because it posits that companies adjust to their target capital structure gradually over a longer time interval (for example, a year).

During the first stage of assessment of the partial adjustment model, we assume that the current debt-to-asset ratio of companies differs from the target value by a certain error (1). Consequently, after obtaining the β coefficients in equation (1), we calculate this target structure for each company. The values of target financial leverage are necessary for calculating the SOA.

$$Lev_{ij,t} = Lev^{*}_{ij,t} + \varepsilon_{ij,t} = \beta_j X_{ij,t-1} + \varepsilon_{ij,t}\,. \quad (1)$$

In equation (1), i designates the company, j – the country, and t – the time period. $Lev^{*}_{ij,t}$ represents the target debt-to-asset ratio and $X_{ij,t-1}$ – the vector of company-specific variables that influence the target level of the debt-to-asset ratio.

At the second stage, after having obtained the form of the partial adjustment equation (2) and the values of the target and current capital structure, we evaluate λ_j – the SOA for companies of each country.

$$Lev_{ij,t} - Lev_{ij,t-1} = \lambda_j \left(Lev^{*}_{ij,t} - Lev_{ij,t-1} \right) + \varepsilon_{ij,t}\,. \quad (2)$$

Inserting equation (1) into equation (2), we get equation (3), which allows us to calculate λ_j:

$$Lev_{ij,t} = \left(\lambda_j \beta_j\right) X_{ij,t-1} + \left(1 - \lambda_j\right) Lev_{ij,t-1} + \varepsilon_{ij,t}\,. \quad (3)$$

However, equation (1) and, consequently, equation (3) ignore the impact of macroeconomic factors and the factors of the external institutional environment. Therefore, it is necessary to add macroeconomic factors and the factors of the country's financial market development Z_{jt} as well as the institutional characteristics Q_{jt} to the set of company-specific factors. Numerous research papers indicate the importance of adding institutional characteristics to the equation when studying the capital structure [8; 13; 25]. In addition, let us show that the equation also takes into consideration the fixed effects of time α_t and companies n_j (unobserved effects characteristic of individual companies, for example, management quality) [10]. After adding the above factors, equation (1) takes the following form:

$$Lev^{*}_{ij,t} = \beta_F X_{ij,t-1} + \beta_M Z_{jt-1} + \beta_I Q_{jt-1} + n_j + \alpha_t + \varepsilon_{ij,t}\,, \quad (4)$$

where β_F is beta for the company parameters, β_M – beta for macroeconomic and financial market factors, and β_I – beta for institutional factors.

Since equation (4) best takes into account the external effects that influence the SOA, we will use it as our main equation taking into account the effects of time, companies, financial market factors and institutional environment factors [9; 10]. It would be incorrect to ignore such external effects, since many authors in the academic literature have come to the conclusion that macroeconomic factors and determinants of financial markets and institutions influence the economic and financial performance of companies [5; 12].

After choosing the form of the equation for the partial adjustment model, it is necessary to consider the technical econometric implementation of these regressions. The ordinary least squares (OLS) method ignores completely company fixed effects and so is undesirable [26]. Besides, this method undervalues the SOA. The fixed effects model, as the name implies, takes into account the fixed effects of companies, yet it provides biased results since it fails to take into consideration the bias inherent in limited panel data. Such bias is characteristic of the data used in studies on corporate finance [24; 27]. We should stress that the fixed effects model usually overestimates the SOA.

The problem of biased results can be solved by applying more advanced econometric techniques. For example, in 1991 M. Arellano and S. Bond proposed the generalized method of moments (GMM). The first step of their methodology consisted in obtaining the first differences using the panel data in order to eliminate time-invariant fixed effects. They showed that lagged values of the dependent variables could be a good instrument for the first difference (independent variable) because this methodology provides more reliable estimates than OLS or fixed effects when the regression residuals are uncorrelated. However, the existence of correlation renders the method ineffective [28].

In 1998, R. Blundell and S. Bond solved the estimation problem in the presence of residual correlation. Besides the first differences of Arellano and Bond, they offered to use lagged first differences as instruments [29].

Although the Blundell-Bond GMM method makes the calculation of the SOA rather accurate, second-order autocorrelation renders it inefficient, similarly to the Arellano-Bond method. This problem was solved by constructing a model with higher lag order [30] and using at least the fourth lag [31].

In 1995, J. Kiviet proposed another approach to regression estimation. This approach (LSDVC) calculates an explicit adjustment using available data [32]. However, when this method was tested on real data, researchers noted that it provides unreliable and inaccurate results in the case of endogenous regressors [33].

Thus, for our study we choose an approach which constructs a regression taking into consideration company fixed effects. This approach does not require extensive panel data, is concise and bears in view individual company characteristics. As for the econometric implementation of this approach, we use the Blundell-Bond estimation method. This method can deal with problems which OLS, the

fixed effects panel model and the Arellano-Bond method are unable to solve. Incidentally, other advanced approaches have their own drawbacks: they are difficult to use with unbalanced panels (a model which takes into consideration a higher lag order) and have endogeneity issues (LSDVC) [24]. Consequently, we shall estimate the following equation:

$$Lev_{ij,t} = \left(\lambda_j \beta_F\right) X_{ij,t-1} + \left(\lambda_j \beta_M\right) Z_{j,t-1} + \\ + \left(\lambda_j \beta_I\right) Q_{j,t-1} + \left(1-\lambda_j\right) Lev_{ij,t-1} + n_j + \alpha_t + \varepsilon_{ij,t}. \quad (5)$$

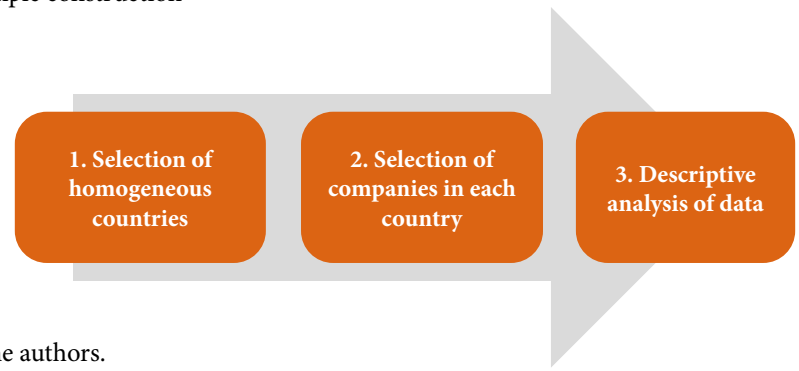
Nevertheless, the econometric regression estimation is not the only method applied in the present study. The reason is that the regression estimation only provides the numerical value of the speed of adjustment (SOA) for each individual country or the sample as a whole. At the same time, one needs other methods to compare the obtained numerical SOA values – for example, the construction of comparative histograms. Researchers have successfully applied such a mixed approach [34]. Moreover, the present study substantiates the estimate of the SOA not only for each country separately but also for samples of countries grouped by the quality of the external institutional environment.

Thus, we are going to use econometric methods to assess the SOA as well as making a preliminary division of countries into samples and subsequently constructing comparative graphs or histograms.

Description of the Sample

We shall now pass to the descriptive characteristic of data. The following steps were taken to compile the sample of companies and countries which is most relevant for the study (Figure 2).

Figure 2. Stages of sample construction



Source: compiled by the authors.

First, we compiled a sample of countries with a level of market maturity similar to the Russian case. Since Russia is an emerging economy according to many international organizations, the sample for analysis comprised countries also considered by global researchers to be on the way to a developed market. Our sample has the following sources:

a) Data of international organizations such as UNO and IMF;
b) Data of the research centre EMGP (Emerging Markets Global Players);
c) Components of market indices, including FTSE, S&P Emerging BMI, and MSCI Emerging Markets.

Table 2. Emerging economies considered in the study

Europe	Eastern and South Asia
Hungary (29 companies)	Indonesia (205 companies)
Greece (183 companies)	China (204 companies)
Poland (204 companies)	Malaysia (203 companies)
Russia (192 companies)	Thailand (200 companies)
	Philippines (202 companies)
	Pakistan (161 companies)
South America	**Western Asia**
Argentina (66 companies)	UAE (55 companies)
Brazil (205 companies)	Saudi Arabia (150 companies)
Mexico (127 companies)	**Africa**
Chile (140 companies)	Republic of South Africa (203 companies)

Source: compiled by the authors.

The final list consists of 17 countries (Table 2). In most countries, the bulk of the sample consists of companies from extractive sectors, electric power companies, telecom and construction companies. Some countries (for example, China) have a significant share of companies from high-tech sectors. The initial sample comprised approximately 25 countries but some of them were excluded for one reason or another. The most common reason was the impossibility of obtaining significant results due to a small number of observations.

Second, for each of the selected emerging economies we chose companies listed on the stock exchange in 2010–2019 (the sample leaves out more recent years as the COVID-19 pandemic could produce biased results). Financial institutions were excluded from the sample. Moreover, if the number of companies in a certain country significantly exceeded 200, the extra companies were eliminated. We did so to avoid a situation where a country would have too much weight in the sample when grouping countries on the basis of the quality of institutional factors. This could lead to biassed results. We chose 200 companies because the number of public joint-stock companies in Russia is 192, and Russia is the main country in this study.

The number of companies for each country in the sample is indicated in parentheses after the country in Table 2. We get an unbalanced data panel for 10 years across 17 countries with 2,729 companies. It should be noted that, if in some country several companies were similar to each other in terms of market capitalization, all of them were included in the sample. This is the reason why some countries are represented by more than 200 companies. However, the number exceeds 200 insignificantly. The data collected for the research is detailed in [35].

Third, before analysing the data it is important to ensure that the country-specific indicators show reasonable minimum, maximum and average values for company-specific, macroeconomic and financial metrics and do not contain outliers, i.e., they are factually correct on the whole. To verify these characteristics, we made a table of the variables used in the present paper (Table 3).

We describe in a separate table the aforementioned institutional variables used in the research (Table 4). They are taken from two different World Bank databases, which is also indicated in this table. Six indicators identified by the World Bank are used as proxy variables for law enforcement. Their values range from –2.5 to 2.5. These indicators cannot be applied as separate variables in the research model as they are strongly interconnected. For example, greater accountability to society may entail lower corruption levels. More effective governance may enhance the quality of regulation in a country. To avoid multicollinearity, an aggregated index from these six indicators must be constructed.

Table 3. Description of dependent and control variables

Variable	Calculation methodology	Data source
Dependent variables for the model of influence of the institutional environment on the speed of adjustment to the target capital structure of companies		
MLEV	Ratio of total debt (long-term and short-term) to market value of company capital, 2010–2019	Authors' calculations based on Bloomberg data
Company-specific control variables		
Profitability	Ratio of operating profit to total assets of companies, 2010–2019	Authors' calculations based on Bloomberg data
Market-to-book value	Ratio of the market value of company capital (amount of debt and market capitalization) to total assets of companies, 2010–2019	
Size	Natural logarithm of company assets, 2010–2019	
Tangibility	Ratio of fixed assets to total assets of companies, 2010–2019	
Macroeconomic control variables		
GDPgr	GDP growth rate in proportions, 2010–2019	World Development Indicators, World Bank
Control variables of the financial market		
MC	Ratio of market capitalization of all companies listed on the stock exchange to GDP of the country, 2010–2019	World Development Indicators, World Bank

Source: compiled by the authors.

Table 4. Independent variables characterizing the institutional environment of the selected countries

Variable	Description of the variable, UOM	Data source
1. Quality of law enforcement		
VA	Right to vote and accountability to society, in points	Worldwide Governance Indicators, World Bank
PS	Political stability and no violence, in points	
GE	Governance efficiency, in points	
RQ	Regulation quality, in points	
RL	Supremacy of law in society, in points	
CC	Control of corruption, in points	
2. Quality of law		
2.1. Quality of creditor protection		
Time	Number of years necessary for the creditor to recover funds in case of borrower's bankruptcy, year	Doing Business, World Bank
Cost	Expenses for bankruptcy procedures, % of property	
Recovery_rate	Present value of a share of property returned to the owner after bankruptcy procedures, cents per dollar	
Strength_legal_rights	Index of creditor legal strength, in points	
Depth_credit_inf	Depth of information about borrowers, in points	
2.2. Quality of shareholder protection		
Extent_dir_liab	Level of managerial responsibility, in points	Doing Business, World Bank
Strength_minor_inv	Protection of minority investor rights, in points	

Source: compiled by the authors.

We constructed one aggregated indicator Inst6 on the basis of six variables indicative of quality of law enforcement, by taking the mean value of these variables. No indicator in Inst6 was assigned a greater or lesser weight. Although each indicator has its own specific features, we consider them to be equally important for assessing quality of law enforcement. The sum of the indicators would allow to take the influence of each of them into account. It is important for us to obtain an averaged value of the indicators leaving out the impact they produce separately. A similar method of averaging the external institutional environment indicators was applied by B. Matemilola et al. [10].

The above six indicators of the World Bank are based on surveys of people's subjective perception of characteristic features of the institutional environment in their country of residence. World Bank experts assert that they are justified for scientific research and cross-country comparison. They argue that citizens' perception is of importance because their behaviour in the economic and other spheres depends on their perception of the norms of conduct and laws in their country. For example, if citizens believe that courts are inefficient and the police is corrupted, they will avoid these agencies. Furthermore, information about people's perception of different institutional features in their country is important for both science and society, because it is difficult to find a more objective alternative to this data. For example, information about corruption is not publicly available, and so it is impossible to find an objective data source about its existence and scope. Finally, even officially recorded data about the effectiveness of governance and the extent of law compliance may not be indicative of the actual state of things. Consequently, data on perception of institutional characteristics is often of greater value [19].

Table 5 presents descriptive statistics of data for Russia. According to it, the data contains no errors or outliers because all variables take on adequate values. For example, market leverage (MLEV) ranges from 0 to 1. Since the data sample was limited, descriptive statistics for each country were analysed manually. When the minimum or maximum values differed significantly, the sample of companies for the country was reviewed and companies with obvious errors in economic indicators were eliminated.

Table 5. Descriptive statistics of variables in the sample for Russia

Variable	Average value	Median	St. deviation	Min.	Max.
MLEV	0.26	0.24	0.22	0.00	0.94
Profitability	0.09	0.09	0.16	-3.57	1.30
Market-to-book value	0.86	0.65	0.81	0.00	10.3
Size	6.77	7.04	2.30	-5.52	12.9
Tangibility	0.45	0.49	0.27	0.00	0.92
GDPgr	0.02	0.02	0.02	-0.02	0.05
MC	0.35	0.37	0.16	0.00	0.62
VA	-1.03	-1.04	0.09	-1.13	-0.88
PS	-0.81	-0.93	0.18	-1.03	-0.53
GE	-0.23	-0.20	0.19	-0.47	0.15
RQ	-0.42	-0.39	0.07	-0.55	-0.34
RL	-0.77	-0.77	0.03	-0.82	-0.72
CC	-0.95	-0.95	0.10	-1.09	-0.82
Time	2.00	2.00	0.00	2.00	2.00
Cost	9.00	9.00	0.00	9.00	9.00
RR	41.4	41.7	1.60	38.6	43.2
Strength_legal_rights	6.65	7.00	2.06	4.00	9.00
Depth_credit_inf	7.00	7.00	0.00	7.00	7.00
Extent_dir_liab	2.00	2.00	0.00	2.00	2.00
Strength_minor_inv	28.5	28.5	0.55	28.00	29.00

Source: compiled by the authors.

Now let us build a correlation matrix for Russian companies that will provide us with a preview of the relationships between the variables. One mostly observes a positive relationship between the dependent variable MLEV and the interest variables. We should note that some variables are not shown in the correlation matrix, because for Russia they assume a single value for the entire time interval under consideration. So, it is impossible to construct a correlation matrix for them. As a result, we see that market leverage correlates with the aggregated variable of the quality of law enforcement, Inst6. It is interesting to note that MLEV correlates negatively with the index of creditor legal protection (Strength_legal_rights) although, according to theory, this indicator should correlate positively.

Corr(MLEV, Inst6) = 0.0140

Corr(MLEV, RR) = 0.0830

Corr(MLEV, Strength_legal_rights) = –0.0724

Corr(LDR, Inst6) = 0.0723

Corr(LDR, RR) = –0.0568

Corr(LDR, Strength_legal_rights) = 0.1055

The interrelation between the dependent variable and control variables is presented below. The correlation of MLEV with Size and Tangibility is also positive.

Corr(MLEV, Profitability) = –0.1428

Corr(MLEV, MB) = –0.2447

Corr(MLEV, Size) = 0.1343

Corr(MLEV, Tangibility) = 0.1977

Corr(MLEV, GDPg) = –0.0788

Corr(MLEV, MC)= –0.0740

Corr(LDR, Profitability) = 0.0531

Corr(LDR, MB) = 0.0744

Corr(LDR, Size) = 0.4198

Corr(LDR, Tangibility) = 0.4054

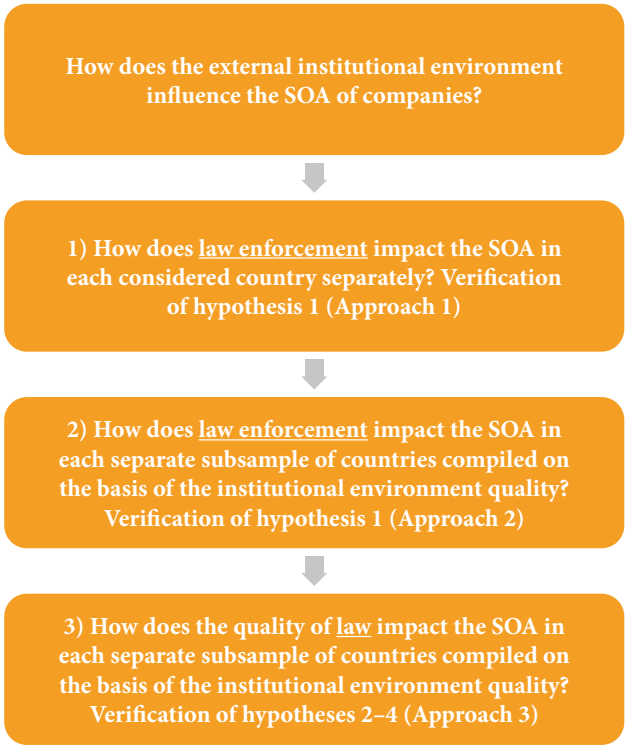
Corr(LDR, GDPg) = 0.0450

Corr(LDR, MC) = –0.0285

Research Results

To illustrate the stages of the empirical research we constructed a step-by-step sequence map (Figure 3).

Figure 3. Empirical research map



Source: compiled by the authors.

As shown by the research map, during the first stage we assessed the speed of adjustment for companies from all selected countries. Table 6 presents the numerical results of evaluation for Russia, while Figure 4 shows the results for the other considered countries.

As we see from Table 6, the SOA is equal to 0.215 (calculated as 1 – 0.785). Tests for AR(1) and AR(2) errors and the Sargan test confirm the high quality of the regression. There is also no multicollinearity (the VIF test gives results below 10). Coefficients for lags of company-specific and institutional characteristics are significant at the 1% level. They include the ratio of the market value of equity to the book value (MB_1), company size (Size_1), and assessment of law enforcement as a factor of the external institutional environment (Inst_6).

At the second stage, based on Table 6 and similar tables representing other considered countries, we obtained the results shown in Figure 4.

According to Figure 4, there is a weak positive correlation between the quality of development of the external institutional environment and the SOA of companies. It is confirmed by the positive slope of the curve of dependence of the SOA on the quality of institutional development in different countries. In the present case, it is challenging to build a regression of influence of the external institutional environment on the SOA across countries, because the number of countries in the sample is small. Such a regression will most likely yield results that will not pass the quality tests. Therefore, additional tooling is necessary for analysis across countries. As indicated earlier, we shall now proceed to make comparative diagrams to obtain results even for such a small sample. Such a mixed approach has already been successfully used by the authors of the present paper [34].

At the first stage of our research, we found λ_j from equation (5) for each country by applying econometric regression analysis; at the second stage, λ_j for all the countries were combined and shown on the same graph (Figure 4). The results of SOA estimation for companies in each considered country are presented in the Appendix. The graph shows that the higher the quality of law enforcement, the higher the companies' SOA.

Thus, we show a positive albeit weak correlation between the external institutional environment and the speed of adjustment to the target capital structure for companies from emerging economies. Thus, hypothesis 1 about the positive influence of the quality of law enforcement on the SOA of company capital is confirmed.

An alternative approach (Approach 2, Figure 3) to verifying the impact of the external institutional environment on the SOA divided the entire sample of countries into three subgroups based on the quality of institutions. The quality of the external institutional environment was also evaluated using the law enforcement proxy Inst6 within a certain interval. Then, each subgroup of countries was assessed by applying equation (5).

The *first subgroup* comprises such countries as Chile, Poland, UAE, Hungary, Malaysia and Greece. The proxy variable of the institutional environment for the quality of law enforcement (Inst6) in these countries ranges

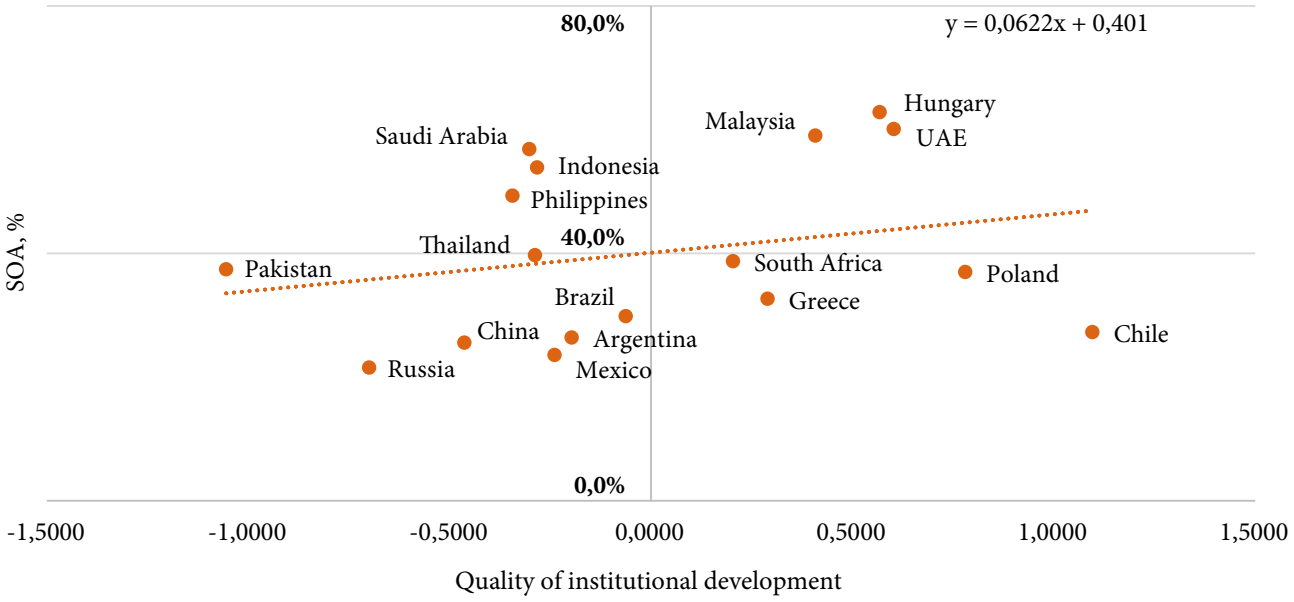
Table 6. Assessment of SOA for Russian PJSCs for 2010–2019

Variables	Ratio	St. deviation	P-value	
MLEV(-1)	**0.7845**	0.0657	<0.0001	***
Const	−0.0092	0.0030	0.0020	***
Profitability_1	−0.0211	0.0247	0.3912	
MB_1	0.0306	0.0099	0.0020	***
Size_1	0.0426	0.0110	0.0001	***
Tangibility_1	−0.0035	0.0522	0.9462	
GDPg_1	−0.4759	0.2676	0.0753	*
MC_1	0.0189	0.0299	0.5274	
Inst6_1	0.6299	0.1413	<0.0001	***
P-value of the test for AR(1) errors	0.0000			
P-value of the test for AR(2) errors	0.5583			
P-value of the test for Sargan's overidentification	0.0111			
Number of observations	1.091			

*** significance at the 1% level, ** significance at the 5% level, * significance at the 10% level.
Dependent variable: market leverage MLEV
Source: calculated by the authors using Gretl.

from 0.29 for Greece to 1.1 for Chile (the maximum value of the proxy variable for all companies from the World Bank database equals 2). The *second subgroup* consists of South Africa, Brazil, Argentina, Mexico, Indonesia and Thailand. For this subgroup the proxy variable value ranges from –0.29 for Thailand to 0.2 for South Africa. The *third subgroup* includes Saudi Arabia, the Philippines, China, Russia and Pakistan. Here, the highest average value for the level of development of the institutional environment for the period of 2010–2019 is –0.3 for Saudi Arabia while the lowest value is –1.06 for Pakistan.

Figure 4. Dependence of company SOA on the quality of law enforcement in emerging economies



Source: compiled by the authors.

Table 7. Comparison of the SOA for subsamples of countries compiled on the basis of the quality of law enforcement

Variable	First subgroup	Second subgroup	Variables	Third subgroup
MLEV_2(-1)	**0.7077*** (0.0854)**	**0.5718*** (0.0727)**	MLEV_3(-1)	**0.8360*** (0.1254)**
Const	-0.0019* (0.0012)	0.0071*** (0.0021)	Profitability_4	0.0655** (0.0272)
Profitability_3	0.0535 (0.0413)	-0.0050 (0.0371)	MB_4	0.0093*** (0.0028)
MB_3	0.0307*** (0.0059)	0.0291*** (0.0058)	GDPg_4	0.1900 (0.2476)
Size_3	-0.0095 (0.0149)	0.0193 (0.0142)		
Tangibility_3	-0.0107 (0.0394)	-0.0348 (0.0355)		
GDPg_3	0.4592*** (0.0932)	0.3625*** (0.1011)		
MC_3	0.0318** (0.0153)	-0.0097 (0.0156)		
Inst6_3	0.0658** (0.0300)	-0.0761* (0.0448)		
Additional limitations	-	2010, 2011, 2018 and 2019 are eliminated from the sample		2010 and 2011 are eliminated from the sample
P-value of the test for AR(1) errors	0.0000	0.0000	P-value of the test for AR(1) errors	0.0000
P-value of the test for AR(2) errors	0.0843	0.3634	P-value of the test for AR(2) errors	0.0919
P- value of the test for Sargan's overidentification	0.0256	0.0316	P- value of the test for Sargan's overidentification	0.0115
Number of observations	4179	2973	Number of observations	2135

*** significance at the 1% level, ** significance at the 5% level, * significance at the 10% level.

Source: calculated by the authors using Gretl.

We should note that for each subgroup a different form of equation (5) was chosen because in each individual case it was necessary to select a model that would meet the requirements of all quality tests (tests for AR(1), AR(2) errors, multicollinearity and the Sargan test). Furthermore, the models differ in the time period. This also stems from the specific features of data in each subgroup. The lag order is different, too, because in some cases the first lag failed to eliminate endogeneity. At the same time, the selected research periods for different country groups differ only slightly – no more than one or two years. The results are presented in Table 7.

As we see from Table 7, the first and second subgroups of countries have higher speeds of adjustment to the target capital structure indicators – 29.2% (1 – 0.7077) and 42.8% (1 – 0.5718), respectively – than the third subgroup (with a lower quality of law enforcement), where the SOA does not exceed 16%.

Thus, approaches 1 and 2 confirm that the quality of law enforcement significantly influences the speed of adjustment to the target capital structure of companies. We showed that higher-quality law enforcement entails a higher speed of adjustment of companies to their target structure. Thus, *hypothesis 1 is confirmed.*

Next, we test how the quality of laws influences the SOA. We replace the proxy variables of interest to check hypotheses 2–4 (Approach 3). This time, the company subsamples are compiled on the basis of indicators from the Doing Business database of the World Bank. These indicators characterize the laws themselves and have nothing to do with law enforcement.

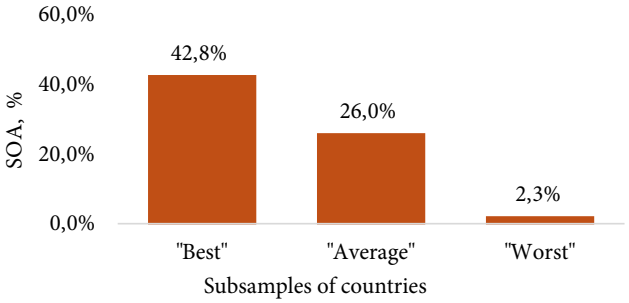
We divide the 17 countries into three subsamples according to the indicators measuring the extent to which laws in a given country favour creditors (time and expenses of the bankruptcy procedure, amount of recovered borrowed funds in case of bankruptcy procedures, index of creditors' legal strength and depth of credit information about borrowers). In addition, we add indicators measuring the extent to which laws favour shareholders (the level of protection of minority shareholder rights and the degree of managerial responsibility).

To analyse each of the seven indicated factors (Table 4), the 17 countries were divided into three approximately equal subsamples in terms of the quality of the external institutional environment (Figures 5–11). It was important to compile equal groups because of the limited number of countries. The results would be less reliable if the number of countries in one group was reduced at the expense of an increase in another group.

The obtained results show that country classifications depend on the considered factor. For example, for the bankruptcy procedure period, Russia was in the subgroup of "average" incomes (the second one), while in terms of minority investor protection it got into the "worst" group (the third one) among all considered emerging economies.

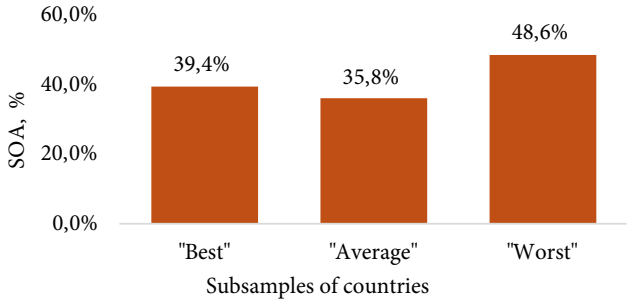
In this approach, we also assessed equation (5) for each of the three subgroups and for each of the seven factors which are indicative of quality of law (Table 4). This allowed us to obtain the speeds of adjustment to the target capital structure for each subgroup of countries depending on the impact of the characteristic features of the external institutional environment. The results are shown in Figures 5–11. Just as in the other approaches, these results are statistically significant and reliable, with a significance level of 10% or above. They take the form of a large number of tables that we shall not present here. Instead, we give comparative diagrams indicating the dependence of the SOA on the determinants of the quality of shareholder and creditor protection.

Figure 5. Dependence of the SOA on the rate of recovery of funds by creditors in case of bankruptcy



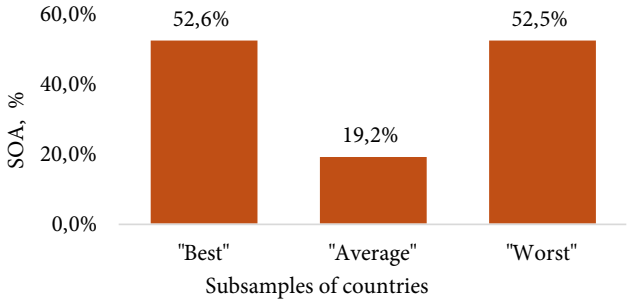
Source: compiled by the authors.

Figure 6. Dependence of the SOA on the expenses for repaying funds to creditors in case of bankruptcy



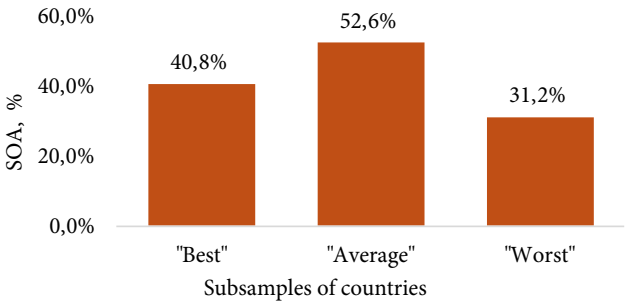
Source: compiled by the authors.

Figure 7. Dependence of the SOA on the amount of funds recovered by creditors in case of bankruptcy



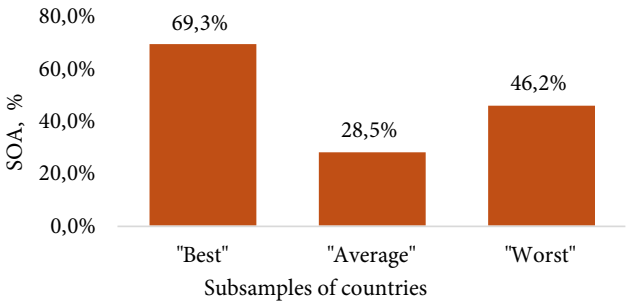
Source: compiled by the authors.

Figure 8. Dependence of the SOA on the index of creditor legal strength



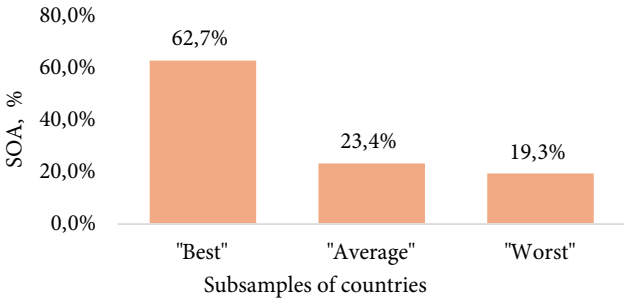
Source: compiled by the authors.

Figure 9. Dependence of the SOA on the depth of credit information about borrowers



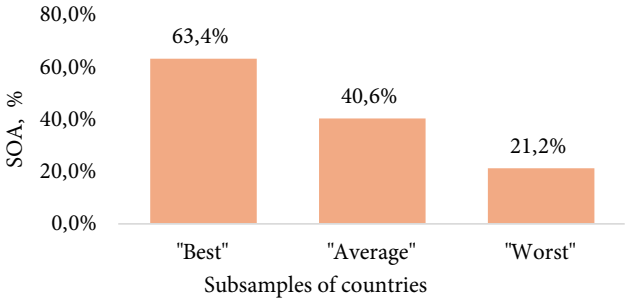
Source: compiled by the authors.

Figure 10. Dependence of the SOA on the extent of managerial responsibility



Source: compiled by the authors.

Figure 11. Dependence of the SOA on the level of minority shareholder protection



Source: compiled by the authors.

As we see, the rate of recovery of funds by creditors in case of bankruptcy (Figure 5), the extent of managerial responsibility (Figure 10) and the level of minority shareholder protection (Figure 11) produce an unambiguous impact on the speed of adjustment to the target capital structure of the considered countries: the group with the "best" institutions has the highest speed of adjustment, the group with "average" institutions demonstrates a moderate speed, while the group with the "worst" institutions shows the slowest speed of adjustment. For example, if the managerial responsibility indicator shows that shareholders have excellent protection from managerial arbitrariness (for the group with the "best" institutions), then the SOA is higher than in other subgroups by 2.5–3 times. With regard to indicators of the rate of recovery of funds by creditors (Figure 7), the depth of credit information about borrowers (Figure 9) and the legal strength index (Figure 8), dependence was confirmed for the groups with the "best" and "worst" institutions: for each of these indicators the SOA in the group with the "best" institutions is always higher than in the group with the "worst" institutions. For example, with regard to the depth of credit information about borrowing companies, the SOA is 69.3% in the group with the "best" institutions and 46.2% in the group with the "worst" institutions.

Thus, we see that the indicators of the group with "average" institutions may both exceed the indicators of the group with the "best" institutions and be lower than the indicators of the group with the "worst" institutions. The reason is that sometimes there is no significant difference in numerical values of institutional indicators of neighbouring groups. Besides, there may be certain inaccuracies in the values of the institutional indicators provided by the global agencies whose data is used in the present study. Therefore, we should compare the groups with the "best" and "worst" institutions, while the group with "average" institutions functions as an interlayer which separates clearly the countries from the other two groups. If we were to divide the entire sample of countries into two groups, it would be difficult to attain such an effect. A negative relationship between the external institutional environment and the SOA of companies was revealed only for the indicator of the expenses of fund recovery by creditors in case of bankruptcy (Figure 6). For this indicator, the SOA in the group with the "best" institutions is 39.4%, which is less than the SOA of 48.6% in the group with the "worst" institutions.

Thus, hypothesis 4 about the positive impact of managerial responsibility and minority investor rights on the SOA is fully confirmed. Hypothesis 3 about the positive impact of the index of creditor legal strength and depth of credit information on the SOA is confirmed upon the assumption that the results of the group with "average" institutions may be disregarded. The results for hypothesis 2 are mixed.

The positive influence of the rate of credit recovery on SOA is fully confirmed. The positive relationship between the share of recovered funds and the SOA is also confirmed (upon the assumption that the results of the group with "average" institutions may be ignored). Nevertheless, hypothesis 2 is disproven with regard to the relationship between the expenses of fund recovery by a creditor in case of bankruptcy procedures (bankruptcy expenses) and the speed of adjustment to the target capital structure.

The conclusions of our research are in line with previously published results about the impact of the quality of law enforcement on the SOA of companies in emerging markets. For example, Matemilola et al. [10] proved that there exists a significant positive relationship between the aforementioned indicators for countries in Asia, Latin America and Eastern Europe yet not for African companies. Given that we consider only one African country – South Africa – in our research, we may assert that our conclusions are generally consistent with Matemilola's study. Our results are also in line with earlier papers concerning the impact of creditor protection on long-term debt in companies. In particular, Awartani et al. [14] argued that the relatively better protection of creditors in MENA countries is related to the higher share of long-term debt in companies. Here, one can apply chain-of-thought reasoning: in the circumstances of higher protection of creditor rights, creditors provide funds to companies more readily, increasing the share of long-term capital and probably affording more opportunities to achieve the target capital structure.

Conclusions

Today, the external institutional environment is receiving increasing attention in the field of financial governance. The reason is that the efficiency of economic transactions and the rapid achievement of financial results are not exclusively determined by financial factors but are also defined by the quality of institutions in a given country. The external institutional environment assumes special importance for emerging economies because they have to catch up with developed countries. One way to achieve this is to improve the institutional conditions in these countries.

We chose the linear partial adjustment model with fixed company effects as our main methodological approach for assessing the impact of the external institutional environment on SOA. This model was estimated by the Blundell-Bond method.

In our study, we put forward four main hypotheses, one of which concerned the influence of law enforcement quality, while the other three focused on the impact of the external institutional environment from the perspective of quality of law. None of the hypotheses were rejected outright. Indeed, two hypotheses about the positive influence of law enforcement and shareholder rights on the SOA were fully confirmed. The other two hypotheses about the positive impact of shareholder and creditor protection on the SOA were confirmed only for groups of countries with the "best" and "worst" institutions (we made the well-grounded assumption that groups of countries with "average" institutions may be disregarded here).

Our empirical study was based on data for 17 countries with emerging markets. Approximately 200 listed companies from each country were included in the sample.

The results showed that the SOA of companies is influenced by the quality of law enforcement and by most of the factors describing the quality of law, including the time period within which bankruptcy procedures are conducted, the share of funds recovered in case of bankruptcy, the index of creditor legal strength, the depth of creditor information on borrowers, the extent of managerial responsibility, and the level of minority investor protection.

The results indicate that it is important to create a favourable institutional environment for companies to allow them to raise additional financing and attain their target capital structures more quickly. Such an environment makes it possible to bring the capital structure up to the target level in a more flexible and rapid manner. This helps companies to maximize their value and enhance efficiency. Moreover, the ability to raise capital and attain the optimal cost of capital within a shorter period of time allows companies to implement their development strategies and deliver on their investment potential.

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Appendix

Speed of Adjustment to the Target Capital Structure for Public Companies in the Countries from the Sample

Country	Lag order	Value	SOA, years
Russia	MLEV(-1)	0.7845*** (0.0657)	0.2155
Argentina	MLEV(-1)	0.7358 *** (0.0247)	0.2642
Brazil	MLEV_3(-1)	0.7014*** (0.0247)	0.2986
Hungary	MLEV_1(-1)	0.3715*** (0.0265)	0.6285
Greece	MLEV(-1)	0.6734*** (0.0781)	0.3266
Indonesia	MLEV(-1)	0.4609*** (0.0490)	0.5391
China	MLEV(-1)	0.7442*** (0.0239)	0.2558
Malaysia	MLEV_3(-1)	0.4094*** (0.1033)	0.5906
Mexico	MLEV(-1)	0.7642*** (0.0538)	0.9462
UAE	MLEV(-1)	0.4081*** (0.0173)	0.5919
Pakistan	MLEV_1 (-1)	0.6258*** (0.0495)	0.3742
Poland	MLEV_1 (-1)	0.6303*** (0.0631)	0.3697
Saudi Arabia	MLEV(-1)	0.4316*** (0.0356)	0.5684
Thailand	MLEV_2(-1)	0.6031*** (0.0498)	0.3969
Philippines	MLEV(-1)	0.5066*** (0.0567)	0.4934
Chile	MLEV_2(-1)	0.7272*** (0.1231)	0.2728
Republic of South Africa	MLEV(-1)	0.6125*** (0.0351)	0.3875

Source: calculated by the authors using model (5).

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Exploring the Heterogenous Effect of Political Risk on Corporate Investment in Emerging Markets[1]

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Abstract

Emerging markets are increasingly important in the global economy but remain vulnerable to political shocks and instability. This study examines how political risk affects corporate investment in emerging markets, accounting for both country- and firm-level heterogeneity. The dataset covers firms listed in 21 emerging markets from 2001 to 2021. The analysis uses a two-way fixed effects panel regression model, complemented by subsample analyses to identify heterogeneous effects. The findings indicate that the effects of political risk vary across subsamples characterized by high and low political risk. Firm-level characteristics such as industry affiliation, cash holdings, asset tangibility, and financial flexibility contribute to these heterogeneous effects. Capital-intensive firms are more exposed to political risk; high asset tangibility amplifies negative effects, while greater cash holdings mitigate them. The study also presents notable findings on key variables in investment theory based on countries' political risk levels. For example, the Tobin's Q ratio, which reflects growth opportunities, has a higher coefficient in low-risk countries. Cash flow sensitivity is lower in these countries, while financial leverage is statistically significant only in high-risk countries. Overall, the study underscores the importance of a stable political environment in emerging markets and recommends that firms carefully manage financial policies, particularly cash holdings, investment irreversibility, and capital budgeting decisions to mitigate the adverse effects of political risk.

Keywords: corporate investments, firm investments, political risk, country risk, emerging markets, developing economies
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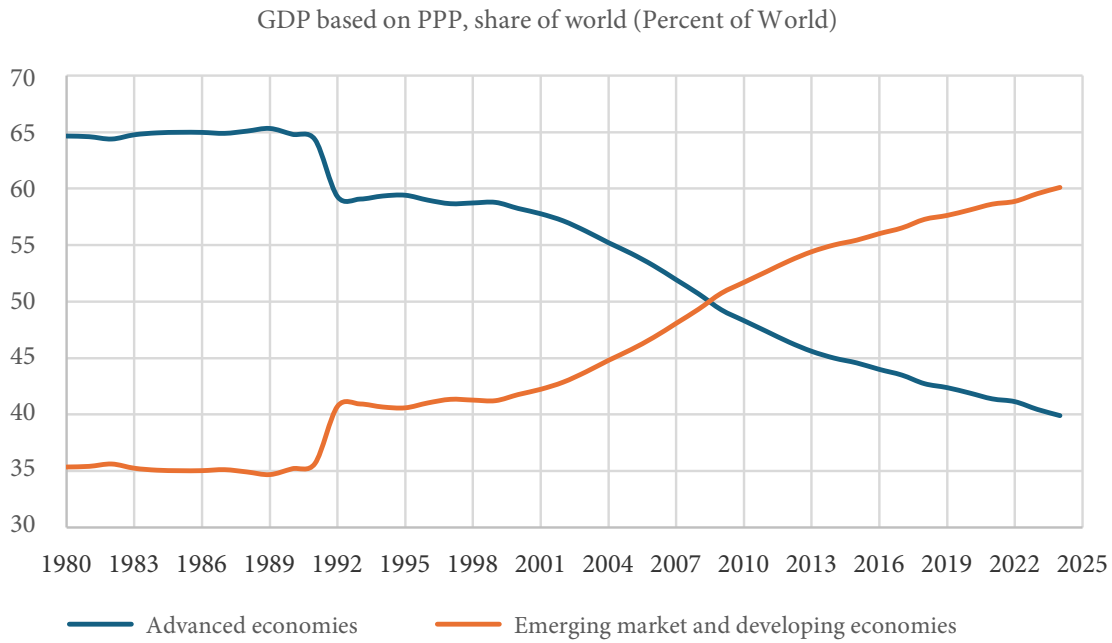
Introduction

Capital expenditures on fixed assets refer to corporate investment in the corporate finance literature. The determinants of the level of corporate investment can be classified into two main groups: firm-level and macro-level factors. Firm-level factors, such as financial constraints, cash flow sensitivity, debt level, growth opportunities, and firm size, are largely interrelated and have been extensively examined in empirical studies [1–5]. Macro-level factors arise from economic, political, and social conditions, and their effects are typically observed at the national or global level [6]. These factors – such as economic policy uncertainty, economic conditions, geopolitical risk, and many others – shape the business environment and affect the level of corporate investment [7–9]. Policy and economics are closely related. In their seminal work "*Why Nations Fail: The Origins of Power, Prosperity, and Poverty*", Acemoglu and Robinson explain cross-national developmental differences through the lens of political institutions and structures [10]. Beyond their long-term impact and role as a key determinant of national development, political factors are also crucial for the business environment. There is a growing interest in the business finance literature regarding political risk and its impact on various financial management decisions, including cash holdings, capital structure, cost of capital, dividend policy, and corporate investment [11–18].

Political risk studies emerged following the financial liberalization movement in the 1970s. Financial liberalization and globalization presented new market opportunities to multinational corporations [6]. Early studies assessed political risk within this framework, primarily viewing it as the negative impact of government interventions on foreign direct investment (FDI) [19–21]. The literature has extensively examined the relationship between political risk and foreign direct investment [22–24]. However, this approach restricts the scope of political risk and neglects other sources of political risk and their effects on domestic investments.

The conceptual assessment of political risk poses challenges because there is no consensus on its definition [6; 25]. Therefore, considering political risk definitions from a holistic perspective allows for a more comprehensive understanding of the concept, moving beyond a narrow focus on government actions and foreign direct investment. According to Howell and Chaddick, political risk refers to the likelihood that political decisions, events, or conditions in a country may adversely affect the business environment [26]. Bremmer and Keat define political risk as any political event that directly or indirectly affects the value of an economic asset. They cite examples of political risk such as wars, economic sanctions, terrorist acts, civil unrest, coup attempts, civil disobedience, corruption, and discriminatory taxation policies [27].

Figure 1. GDP Based on Purchasing Power Parity: Emerging vs. Developed Economies



Source: Compiled by authors from IMF DataMapper (https://www.imf.org/external/datamapper/profile/OEMDC).

The study focuses on the relationship between political risk and corporate investment in 21 emerging markets. The role of emerging economies in the global economy has been increasing steadily over time. According to Figure 1, which compares the GDP (gross domestic product) of emerging and developed economies, the share of emerging economies was approximately 35% in 1980. It began to increase rapidly after the 1990s and surpassed that of developed economies after 2008. Despite their significant economic role, emerging markets are often characterized by high levels of risk and are vulnerable to political shocks. For instance, China, one of the largest emerging markets, has

experienced ongoing trade tensions with the United States due to tariffs, while India faces geopolitical disputes with its neighbor, Pakistan. Although some emerging markets are exposed to high political risk, others, including Poland, South Korea, and Chile, maintain relatively stable political environments. While the main purpose of this study is to explain the relationship between political risk and corporate investment, it also takes into account this heterogeneity.

The research sample consists of firms listed on emerging market stock exchanges, covering the period from 2001 to 2021. We employed a two-way fixed effects estimator in the panel regression analysis. To examine the heterogeneous impact of political risk, the research sample was classified based on the political risk ratings of their respective countries. Moreover, we conducted subgroup analyses based on firm characteristics such as cash ratio, asset tangibility, and financial flexibility to further explore the sources of firm-level heterogeneities. To the best of our knowledge, no prior study has examined the impact of political risk on corporate investment in emerging markets using a large research sample and considering their heterogeneous profiles.

The rest of the paper is organized as follows: Section Two presents the theoretical framework and hypotheses; Section Three describes the research method; Section Four includes the findings and discussion; and Section Five concludes the study.

Literature and Hypotheses

The relationship between political risk and corporate investment can be addressed with capital budgeting techniques, particularly net present value (NPV), which is the most preferred method in practice. Expected cash flows and cost of capital are two determinants of the net present value of an investment project [6]. Political issues can lead to negative deviations in expected cash flows and increase the cost of capital. These components can be adapted to mirror political risk [25; 28]. In addition to the NPV perspective, real options theory emphasizes investment irreversibility and sunk costs when facing uncertainties. Within the context of the real options theory, firms tend to adopt a "wait and see" approach, postponing new investments until uncertainties diminish and business conditions become more favorable.

Shareholders and creditors increase risk premiums in response to political risk. Empirical findings support the theoretical expectation regarding the relationship between political risk and the cost of capital. For instance, it has been documented that political risk increases the cost of capital in MENA countries [29]. Another study focuses on developed and emerging markets and shows that terrorism increases the cost of debt, with the effect being more pronounced in emerging markets [30]. Similarly, other studies report consistent findings regarding the cost of equity in relation to firm-level political risk and geopolitical risk [17; 31].

These findings indicate that political risk affects the cost of capital. In light of this, firms may delay, cancel, or reduce their investments due to the increased cost of capital. For example, it has been found that firms lower their investment levels during national elections due to political uncertainty [32]. Various forms of political risk such as geopolitical tensions, corruption, and terrorism have also been shown to negatively influence corporate investment [5; 33–35]. Likewise, recent studies highlight that firm-level political risk seriously influences corporate investment decisions [36; 37]. Drawing upon the theoretical framework, the relevant empirical literature, and the distinctive economic roles and political structures of emerging markets, we propose the following hypothesis:

Hypothesis 1: Political risk adversely affects corporate investments in emerging markets.

To explain country-level and firm-level heterogeneities, we developed sub-hypotheses. First, we addressed country differences based on their political risk levels. The main hypothesis employs a holistic approach. However, the political risk profiles of emerging markets differ substantially. While some emerging markets are more exposed to political risk, others aren't [6]. This difference affects the investment evaluation process. Firms operating in countries with high political risk take it into account in investment decisions, and political risk lowers their investment levels. An important example is the Russia–Ukraine war, which also illustrates the heterogeneous effects of political risk. According to the findings of Caldara et al. [38], based on firms from 50 countries, companies that explicitly discussed the war in their reports reduced their investment. This indicates the importance of country-level heterogeneities in shaping firm investment policies. Another example concerns the China-USA trade war. China, one of the major emerging markets, has long experienced tariff tensions with the United States. These trade wars decrease capital expenditures, and firms affected by tariff sanctions tend to reduce corporate investments [39]. Accordingly, we proposed the following hypotheses:

Hypothesis 1a: Political risk negatively affects corporate investment in emerging markets with high levels of political risk.

Hypothesis 1b: Political risk negatively affects corporate investment in emerging markets with low levels of political risk.

Cohen and Yagil explain the differences across industries in terms of their unique financial needs and operating conditions, as well as the imitation effect, which refers to firms mimicking the financial behavior of other firms operating in the same industry [40]. Sectoral dynamics alter the relationship between political risk and corporate investment. Factors such as sectoral growth trends, sectoral responses to macroeconomic conditions, capital or labor intensity, and government incentives may either mitigate or amplify the effect of political risk on corporate investment. The literature provides evidence of sector-specific studies examining the impact of political risk and its different forms on corporate investment. For example, it has been document-

ed that firm-level political risk adversely affects corporate investment in the hospitality and tourism sector [41]. Similarly, geopolitical risk has been reported to negatively influence corporate investment in the Australian metals and mining sector [42]. Based on these findings, we developed the following hypothesis:

Hypothesis1c: The relationship between political risk and corporate investment varies across sectors.

Firms can maintain their investment activities despite operating in politically risky environments due to their specific characteristics. On the other hand, they are also more vulnerable to political risk because of these characteristics [6]. We addressed firm-level heterogeneities with respect to financial flexibility, cash holdings, and tangibility. These factors respectively represent the firm's ability to access external funds, a buffer against uncertainty, and the degree of investment irreversibility.

Financial flexibility refers to a firm's ability to preserve debt capacity without experiencing financial distress. It enables firms to sustain their investment activities during periods of crisis. Financially flexible firms rely less on internal funds for investment and perform better than financially inflexible firms [43]. In the context of emerging markets, financial flexibility offers several advantages: it enhances firms' investment capacity, reduces cash-flow sensitivities, increases firm value, and mitigates the negative effects of unexpected shocks [44]. Similarly, Chortareas and Noikokyris [45] highlight its positive impact on corporate investment in conditions of uncertainty. Considering these findings, we argue that financial flexibility can attenuate the adverse effects of political risk on corporate investment. When political risk rises and access to external finance becomes more difficult, financially flexible firms are able to rely on their unused debt capacity to continue investing [6]. Therefore, we develop the following hypothesis to compare the effect of political risk on financially flexible and inflexible firms.

Hypothesis 1d: Financial flexibility moderates the relationship between political risk and corporate investment in emerging markets.

Cash policy is closely related to investment policy, as cash assets are one of the main sources of internal funding for corporate investments [46]. The precautionary motive is one of the primary reasons behind cash holdings. Firms hold cash to maintain operations in the presence of uncertainty [47]. In addition, firms tend to hold more cash in response to political risk [13]. When political risk is high, the cost of capital also increases [29], making it more difficult to access external finance. In this context, cash holdings serve as a source of liquidity, helping to mitigate financial constraints and smooth the effects of cash flow volatility. According to Le and Tran [35], cash holdings mitigate the adverse impact of geopolitical risk on corporate investment. To examine the moderating effect of cash holdings on the relationship between political risk and corporate investment, we develop the following hypothesis:

Hypothesis 1e: Cash holdings moderate the relationship between political risk and corporate investment in emerging markets.

Tangibility is defined as the ratio of fixed assets to total assets. A higher level of tangibility implies greater investment irreversibility, and vice versa. Firms with higher tangibility tend to delay new investments under uncertainty due to the costly nature of exit options [48]. Capital expenditures are typically considered sunk costs and are therefore irreversible. Investment irreversibility increases firms' exposure to uncertainty not only in regard to future costs and prices but also in terms of the optimal timing of investments and the unpredictability of their ultimate cost. Firms may postpone investment decisions when these factors are unclear – particularly when the capital involved is highly specific and difficult to recover [49]. Empirical studies indicate that firms delay and reduce their investments under uncertainty, and this effect is more pronounced for firms with higher investment irreversibility [50; 51]. We argue that firms with higher tangibility may respond to political risk by delaying new investments due to the greater irreversibility of their capital. Based on this reasoning, we propose the following hypothesis:

Hypothesis 1f: Tangibility moderates the relationship between political risk and corporate investment in emerging markets.

Research Method

The research sample consists of firms listed on stock exchanges in emerging markets. Emerging markets are determined based on the MSCI classification. Although Colombia, Hungary, and Czech Republic are classified as emerging markets by MSCI, they are excluded from the study due to insufficient firm-level data. Appendix 1 provides a detailed overview of the final sample, displaying the number of firms by country. The study covers the period from 2001 to 2021. To mitigate the influence of outliers, firm-level variables are winsorized at the 1st and 99th percentiles. To test the stationarity of the variables, we employed the Fisher ADF and Fisher PP unit root tests, and the results are reported in Appendix 2.

$$INV_{i,t+1}=\beta_0+\beta_1 PR_{j,t}+\beta_2 TQ_{i,(t)}+\beta_3 CF_{i,t+1}+\beta_4 LEV_{i,t}+\beta_5 SIZE_{i,t}+\beta_6 NWC_{i,t}+\beta_7 SG_{i,t}+$$
$$+\beta_8 DDIV_{i,t}+\beta_9 GDP_{j,t}+\beta_{10} Firm_{i,t}+\beta_{11} Year_{i,t}+\varepsilon_{i,t}. \quad (1)$$

To test the relationship between political risk and corporate investment, we employed the model illustrated in Equation 1. Following prior literature, we specified the model using lagged values of all independent and control variables, except for *CF* [3; 5; 32].

Table 1. Variables

Variables	Measurement
INV	Corporate Investment = CAPEX / Total Assets
TQ	Tobin's Q = (Total Assets – Book Value of Equity + Market Value) *(t)* / Total Assets *(t)*
CF	Cash Flow Ratio *(t)* = (EBITDA – Dividends + Depreciation) *(t)* / Total Assets *(t–1)*
LEV	Leverage *(t)* = Total Liabilities *(t)* / Total Assets *(t)*
SIZE	Firm Size *(t)* = Natural Logarithm of Total Assets
NWC	Net Working Capital Ratio = (Current Assets – Short-term Liabilities) *(t)* / Total Assets *(t)*
SG	Sales Growth *(t)* = [Sales *(t)* – Sales *(t–1)*] / Sales *(t–1)*
DDIV	Dividend Dummy: 1 if dividend is paid, 0 otherwise
IND_LEV	Industry-level average leverage values
MTB	Market-to-Book Ratio = Market Value / Book Value
TANG	Asset Tangibility = Net Fixed Assets / Total Assets
GDP	GDP growth rate
PR	ICRG Political Risk Ratings
INF	Consumer Price Index

All firm-level variables were obtained from the Refinitiv. Political risk ratings are taken from the ICRG. GDP growth rate and consumer price index data were obtained from the World Bank. Since GDP data for Taiwan is not provided by the World Bank, Taiwan's GDP growth rate was obtained from the DGBAS (Directorate General of Budget, Accounting and Statistics Taiwan).

Table 1 presents the details of the variables used in the study. The theoretical framework of the variables is explained below [6]:

INV is defined as the ratio of capital expenditures to total assets and serves as a measure of corporate investment. Capital expenditures refer to the acquisition of fixed assets intended to maintain and expand a firm's operations. The funds allocated to capital expenditures are generally used for new projects.

TQ refers to Tobin's Q ratio and serves as a proxy for growth opportunities, being one of the main determinants of corporate investment. According to Q theory, firms should invest until the marginal cost of investment equals the marginal increase in the market value of the firm. Eberly et al. investigate various investment models and find that Q theory-based models provide the best statistical explanatory power [52]. Q theory states that corporate investment is a function of firms' market value and the replacement cost ratio. When the q ratio is above 1, firms are more likely to invest; conversely, when the q ratio is below 1, firms tend to avoid new investment activities [53].

CF stands for cash flow and allows the firm to invest during periods of financial constraint. With higher cash flows, firms can invest using internal financing and do not need to rely on external debt. According to Q theory, explaining corporate investment through the Q ratio alone is considered sufficient. However, the literature argues that the Q ratio is insufficient to fully account for investment behavior, and that additional factors are required [54]. Based on this argument, we employ cash flow (CF) to capture the role of internal funds in corporate investment.

LEV denotes financial leverage. According to the pecking order theory, the relationship between financial leverage and corporate investment is expected to be negative [46]. The pecking order theory suggests that external financing should be considered the last resort for funding investments. Empirical findings provide evidence in support of this theory [55; 56]. On the other hand, this argument may not hold when the cost of external funds is relatively low. A lower cost of debt reduces the cost of capital, thereby encouraging firms to undertake more investment.

SIZE represents firm size. Smaller firms are generally driven by stronger growth motives compared to larger firms. On the other hand, larger firms face fewer financial constraints and can access external funds more easily. Empirical studies provide no clear consensus on the relationship between firm size and corporate investment [9; 57].

Table 2. ICRG Political Risk Components

Bekaert et al. [67]	*ICRG*	Ratings
Quality of institutions	Law and order	6
	Bureaucratic quality	4
	Corruption	6
Conflict	Internal conflict	12
	External conflict	12
	Religious tensions	6
	Ethnic tensions	6
Democratic tendencies	Military in politics	6
	Democratic accountability	6
Government actions	Government stability	12
	Socioeconomic conditions	12
	Investment profile	12
Political risk		**100**

Source: Adopting from Bekaert et al. [67].

NWC refers to net working capital and serves as a proxy for the firm's ability to meet short-term liabilities. A higher level of net working capital indicates stronger liquidity and reduces the need for external financing. The contribution of NWC to corporate investment is analogous to the positive role of cash holdings. The literature highlights the positive effect of cash holdings on corporate investment [58–60]. Moreover, this relationship becomes more pronounced under conditions of heightened uncertainty [32].

SG, sales growth, is employed as a proxy for firm efficiency. Increased revenues reflect the demand for a company's products and services. Firms facing sustained demand are more likely to undertake additional investment, which is consistent with the accelerator theory. Moreover, sales growth serves as an indicator of growth opportunities [57]. Accordingly, it is expected that sales growth positively affects corporate investment.

DDIV, a dummy variable for dividend payments, serves as an indicator of financial constraints [3; 61]. Firms that have difficulty paying dividends may be subject to financial constraints even during periods of low financing costs [3]. A finding by Fazzari et al. [62] shows that firms with low dividend payout ratios are more dependent on cash flow for their investment activities. This situation indicates that firms that pay low dividends are more exposed to financial constraints [61].

GDP, the annual growth rate of gross domestic product, is included to control for the effect of country-level conditions. PR represents the political risk rating of ICRG and serves as the main independent variable in this study. There is no consensus on the dimensions of political risk. Howell [63] discussed various political risk assessment models and their deficiencies. The *ICRG* political risk rating is considered the most comprehensive among these models. Moreover, it is frequently preferred by scholars in empirical research as a proxy for political risk [29; 64–66]. Therefore, the ICRG political risk rating was adopted in this study.

The dimensions of the ICRG political risk rating are illustrated in Table 2. Additionally, we refer to the classification approach proposed by Bekaert et al. [67], which enables the

Table 3. Descriptive Statistics of Political Risk

	Brazil	Chile	China	Egypt	Greece	India	Indonesia
Mean	34.31	23.70	37.07	42.00	26.84	39.02	42.70
S.D.	(2.15)	(2.91)	(4.83)	(4.74)	(4.16)	(2.45)	(3.59)
	South Korea	**Kuwait**	**Malesia**	**Mexico**	Peru	**Philippines**	**Poland**
Mean	22.76	28.58	27.69	32.40	36.18	36.97	22.91
S.D.	(1.31)	(4.35)	(2.37)	(4.98)	(1.78)	(2.18)	(1.82)
	Russia	**Saudi Arabia**	**South Africa**	**Taiwan**	**Thailand**	**Turkiye**	**UAE**
Mean	38.68	32.25	33.81	21.75	39.97	42.45	22.68
S.D.	(3.99)	(2.01)	(2.40)	(1.83)	(5.86)	(5.15)	(1.34)

S.D. is standard deviation. UAE is United Arab Emirates.

Source: Derived from the ICRG political risk ratings by the authors.

alignment of conceptually similar components within political risk indices. To examine the effect of political risk in a more detailed manner, the model presented in Equation 1 is re-estimated using the newly constructed components. According to the ICRG methodology, political risk ratings range from 0 to 100, where 0 indicates the highest level of political risk and 100 – the lowest. This coding may lead to confusion in regression analysis. To address this issue, researchers often reverse the scale by subtracting the ICRG score from 100 [29; 35]. We followed this approach; therefore, in our analysis, a score of 0 represents the lowest level of political risk, while a score of 100 indicates the highest.

Findings

Descriptive Statistics

Appendix 3 demonstrates the descriptive statistics for all variables. In this section, we limit our discussion to the political risk ratings. Table 3 presents the descriptive statistics of political risk ratings.

According to the mean PR values during the research period (2001–2021), the countries with the highest political risk are Indonesia (42.70), Egypt (42.01), and Turkiye (42.45). Among the BRICS countries (Brazil, Russia, India, China, and South Africa), which are considered key emerging markets, Russia (38.68), India (39.02), and China (37.07) exhibit relatively higher mean political risk levels, while South Africa (33.81) and Brazil (34.32) have lower values. Chile (23.70), Poland (22.91), South Korea (22.76), Taiwan (21.75), and the United Arab Emirates (22.68) display the lowest mean political risk values among the countries in the sample.

Correlation Analyses

Table 4 presents the correlation matrix. The correlations between INV and the independent variables are relatively low. Among the independent variables, CF shows the highest correlation with INV. The correlation between NWC and INV is -0.19. Although liquid assets are useful for short-term financing in corporate investment, their negative correlation with INV may indicate a trade-off between cash holding and investment decisions. The other variables do not exhibit a strong correlation with INV.

While the correlation between *TQ* and *CF* is positive (0.257), the correlation between *LEV* and *TQ* is negative (-0.116). There is a strong negative correlation between N*WC* and *LEV* (-0.591). Overall, the low intercorrelations among most explanatory variables support the reliability of the regression model and indicate the absence of multicollinearity.

Main Findings

Regression results based on the model specified in Equation 1 are reported in Table 5. As shown in Appendix 1, the research sample may introduce bias due to the overrepresentation of certain countries. Specifically, China, South Korea, Taiwan, and India comprise nearly 70% of the total sample. To mitigate this issue, and in line with previous studies, we employed the Weighted Least Squares *(WLS)* method, assigning weights based on the inverse of the number of firms per country [35; 68; 69].

Additionally, we categorized the sample into two groups based on the political risk levels of the countries: low-risk and high-risk. Countries with a mean political risk score below 30 are classified as low-risk countries, including

Table 4. Correlation Matrix

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
(1) INV	1.000									
(2) TQ	0.070	1.000								
(3) CF	0.263	0.257	1.000							
(4) LEV	0.041	-0.116	-0.198	1.000						
(5) SIZE	0.018	-0.056	-0.065	0.261	1.000					
(6) NWC	-0.187	0.141	0.156	-0.591	-0.273	1.000				
(7) SG	0.087	0.077	0.259	0.062	0.001	-0.008	1.000			
(8) DDIV	0.050	0.008	0.149	-0.146	0.208	0.146	-0.064	1.000		
(9) GDP	0.085	0.098	0.015	0.041	0.032	-0.021	0.133	-0.026	1.000	
(10) PR	0.039	0.188	-0.014	0.060	0.125	-0.045	0.008	-0.029	0.145	1.000

Source: Authors' calculations.

Table 5. Political Risk and Corporate Investment

$INV_{i,t+1}$	I	II WLS	III Low PR	IV High PR
$TQ_{i,t}$	0.001*** (0.000)	0.001*** (0.000)	0.004*** (0.000)	0.001*** (0.000)
$CF_{i,(t+1)}$	0.077*** (0.003)	0.048*** (0.007)	0.068*** (0.005)	0.081*** (0.004)
$LEV_{i,t}$	-0.006** (0.002)	0.000 (0.004)	0.004 (0.004)	-0.012*** (0.003)
$SIZE_{i,t}$	-0.006*** (0.001)	-0.010*** (0.001)	-0.007*** (0.001)	-0.005*** (0.001)
$NWC_{i,t}$	0.028*** (0.002)	0.029*** (0.004)	0.033*** (0.003)	0.024*** (0.003)
$SG_{i,t}$	0.003*** (0.000)	0.003*** (0.001)	0.004*** (0.001)	0.003*** (0.000)
$D\_DIV_{i,t}$	0.006*** (0.001)	0.004*** (0.001)	0.005*** (0.001)	0.007*** (0.001)
$GDP_{j,t}$	0.025*** (0.006)	0.063*** (0.014)	0.036*** (0.008)	0.076*** (0.013)
$PR_{j,t}$	-0.033*** (0.008)	-0.022* (0.013)	0.025 (0.017)	-0.023** (0.011)
Constant	0.165*** (0.011)	0.237*** (0.022)	0.156*** (0.019)	0.154*** (0.014)
Firm Effect	Yes	Yes	Yes	Yes
Time Effect	Yes	Yes	Yes	Yes
Adjusted R^2	0.090	0.081	0.080	0.099

*** p < 0.01, ** p < 0.05, * p < 0.1.

Robust standard errors clustered at the firm level are presented in parentheses.

Source: Authors' calculations.

Chile, Greece, South Korea, Kuwait, Malaysia, Poland, Taiwan, and the UAE. Conversely, countries with a mean political risk score above 30 are considered high-risk countries, including Brazil, China, Egypt, India, Indonesia, Mexico, Peru, the Philippines, Russia, Saudi Arabia, South Africa, Thailand, and Turkiye.

The findings presented in Table 5 are consistent with the theoretical framework. *TQ* refers to Tobin's Q ratio and serves as a proxy for growth opportunities. Firms with greater growth opportunities and higher market valuation tend to invest more. Furthermore, the relationship between *TQ* and investment *(INV)* differs between the low political risk *(PR)* and high political risk *(PR)* subsamples. The coefficient of *TQ* is higher in the high PR subsample compared to the low PR group. This suggests that political risk amplifies the sensitivity of investment to growth opportunities in countries with high political risk [6].

Similarly, the relationship between *CF* and *INV* is also positive; however, cash flow sensitivity is higher for firms operating in countries with high political risk compared to those in low-risk countries. Firms operating in countries with elevated political risk tend to depend more on internal financing, as external funding becomes more costly or uncertain in such environments [6].

As shown in Column 1, *LEV* has a negative and statistically significant effect on corporate investment in the unadjusted sample. On the other hand, the relationship between *LEV* and *INV* is statistically insignificant in the findings based on the WLS method. Furthermore, this relationship differs across the high-risk and low-risk country samples.

LEV has a negative effect on corporate investment in politically high-risk countries. This can be addressed from two perspectives. First, external funds tend to be more costly in countries with higher political risk. Second, firms may prefer to avoid financing their investments through debt [6].

SIZE is negatively associated with investment across all model specifications. The role of firm size in corporate investment does not change with respect to political risk levels. On the other hand, the effect of firm size on corporate investment indicates that larger firms make fewer capital expenditures. The results suggest that smaller firms tend to invest more, driven by growth motivations [6].

SG has a positive impact on corporate investment, and this effect is more pronounced in the low-PR sample. The result supports the accelerator theory, as firms facing stronger demand are more likely to increase their investment [6].

The relationship between *NWC* and *INV* is positive, as expected. This indicates the importance of short-term liability and liquid asset management for corporate investment levels. Moreover, this finding is more evident in the low-PR sample. Firms operating in low-PR environments appear to rely less on *NWC* compared to those in high-PR environments [6].

The relationship between *PR* and *INV* is significantly negative in the analysis based on the unadjusted sample. However, the *PR–INV* relationship becomes statistically weaker under the *WLS* estimation. In addition, the nature of this relationship varies depending on the political risk level of the sample. Firms in countries with low political risk are not significantly affected by political risk, whereas firms in high-risk countries face a significant negative effect. These findings reflect the heterogeneity among emerging markets in terms of political risk exposure. The firm-level differences mentioned above support the presence of heterogeneity across countries. Notably, the *LEV–INV* relationship differs significantly between the low- and high-risk country samples. Further differences are observed in the *CF–INV* and *NWC–INV* relationships. Cash flow sensitivity is higher in countries with high political risk, indicating that firms in these environments rely more heavily on internal financing. Conversely, firms in countries with low political risk appear to finance investment more through net working capital [6].

The main finding of the study confirms Hypothesis 1: Political risk negatively affects corporate investment in emerging markets. This finding is consistent with theoretical expectations and with empirical evidence from previous studies, most of which are based on relatively small samples or examine specific types of political risk [5; 33; 35–37; 42; 70–72].

Moreover, Hypothesis 1a, which states that political risk negatively affects corporate investment in emerging markets with high levels of political risk, is supported by the empirical results. Political risk has a significant impact on corporate investment in countries with high levels of political risk. Finally, Hypothesis "1" _"b" , which posits that political risk negatively affects corporate investment in emerging markets with low levels of political risk, is not supported by the findings. The effect of political risk varies according to the level of political risk [6].

Political Risk Components and Corporate Investment

As demonstrated by the findings above, the impact of political risk varies according to the political risk level classification of the sample. To gain a deeper understanding of this relationship, we employed the main regression models for the individual components of political risk, based on the classification proposed by Bekaert et al. [67]. Table 6 presents the results on the relationship between these political risk components and corporate investment.

Table 6. Political Risk Components and Corporate Investment

$INV_{i,t+1}$	High PR Sample			
Control Variables	Yes	Yes	Yes	Yes
Quality of institutions	0.031 (0.08)			
Conflict		-0.14*** (0.03)		
Democratic tendencies			0.52*** (0.07)	
Government actions				-0.12*** (0.013)
Firm and time effects	Yes	Yes	Yes	Yes
R^2	0.09	0.09	0.09	0.09

$INV_{i,t+1}$	Low PR Sample			
Control Variables	Yes	Yes	Yes	Yes
Quality of institutions	0.18*** (0.07)			
Conflict		0.005 (0.038)		
Democratic tendencies			0.06 (0.07)	
Government actions				0.02 (0.02)
Firm and time effects	Yes	Yes	Yes	Yes
R^2	0.07	0.07	0.07	0.07

*** p < 0.01, ** p < 0.05, * p < 0.1.
Robust standard errors clustered at the firm level are presented in parentheses.
Source: Authors' calculations.

As mentioned, Table 2 shows that the "quality of institutions" variable is constructed as the sum of the *ICRG* indicators for "law and order," "bureaucratic quality," and "corruption." This component has a positive and statistically significant effect on corporate investment in the sample with low political risk, whereas its effect is not significant in the high-risk sample. Moreover, other political risk components namely conflict, democratic tendencies, and government actions do not significantly influence corporate investment in low-risk countries. However, these relationships differ substantially in high-risk environments [6].

The "conflict" component consists of *ICRG* scores for internal conflict, external conflict, religious tensions, and ethnic tensions. This dimension reflects violence-oriented political risks such as terrorism, war, and civil unrest. In the sample with high political risk, conflict is found to negatively affect corporate investment. A similar adverse relationship is observed for the "government actions" component, which includes government stability, socioeconomic conditions, and the investment profile. Firms operating in high-risk countries reduce their investment in response to increases in these risk factors [6].

The "democratic tendencies" component is composed of two *ICRG* indicators: military involvement in politics and democratic accountability. Interestingly, the relationship between democratic tendencies and corporate investment is positive. Firms in countries with high political risk appear to maintain their capital expenditures despite the presence of such risks. Two possible explanations may account for this finding. First, firms might not incorporate these risks into the capital budgeting process, thereby underestimating their potential impact on future cash flows and the cost of equity indicating a valuation issue in project evaluation. Second, firms may choose to proceed with investments despite these risks in an effort to avoid a future increase in the cost of capital [6; 36].

Sectoral Analyses

The reaction of the sectors to political risk can be different for several reasons. Firstly, firms may be operating with low tangible assets and their operations may be closely related with human capital. Secondly, some sectors have sustainable demand, and their cash flow is not significantly affected by political shocks [6]. Moreover, some sectors can be under government protection, and their cost of capital may not increase in the presence of political risk. To address the effect of political risk on corporate investment in different sectors, we examined the main regression model for the main sectors. Table 7 provides a detailed overview of the sectoral regression results, illustrating the heterogeneous impact of political risk on investment decisions.

The findings reveal remarkable sectoral variations in the impact of political risk on corporate investment. A statistically significant negative relationship between political risk and investment is observed in the logistics, manufacturing, retail, and mining sectors. In contrast, no statistically significant relationship is monitored for the energy, healthcare, and tourism sectors. Interestingly, firms in the technology sector in emerging markets tend to increase their investments even in the presence of political risk. Overall, the sectoral analysis suggests that sectors with high levels of tangible assets are more vulnerable to the adverse effects of political risk [6]. By contrast, human capital–oriented sectors, such as healthcare and technology, are not significantly affected by political risk. In line with these findings, Hypothesis "1" _"c" cannot be rejected. The effect of political risk on corporate investment differs across sectors.

Table 7. Political Risk and Corporate Investment: Sectoral View

$INV_{i,t+1}$	Energy	Technology	Healthcare	Logistics
$TQ_{i,t}$	0.003***	0.001***	0.002***	0.003**
	(0.001)	(0.000)	(0.000)	(0.001)
$CF_{i,(t+1)}$	0.097***	0.079***	0.045***	0.145***
	(0.021)	(0.007)	(0.011)	(0.028)
$LEV_{i,t}$	-0.045***	0.007	0.005	-0.008
	(0.016)	(0.006)	(0.008)	(0.016)
$SIZE_{i,t}$	-0.006	-0.005***	-0.012***	-0.003
	(0.004)	(0.001)	(0.002)	(0.005)
$NWC_{i,t}$	-0.021	0.029***	0.042***	0.025*
	(0.014)	(0.005)	(0.007)	(0.015)
$SG_{i,t}$	0.001	0.003***	0.004***	0.003
	(0.002)	(0.001)	(0.001)	(0.002)
$DDIV_{i,t}$	0.022***	0.005****	0.004*	0.004
	(0.004)	(0.001)	(0.002)	(0.005)
$GDP_{j,t}$	0.077	0.023*	0.035	0.023
	(0.063)	(0.013)	(0.031)	(0.050)
$PR_{j,t}$	-0.021	0.064***	0.019	-0.114*
	(0.060)	(0.024)	(0.031)	(0.068)
Constant	0.191***	0.128***	0.262***	0.152*
	(0.069)	(0.024)	(0.037)	(0.091)
Firm and Time Effects	Yes	Yes	Yes	Yes
Adjusted R^2	0.14	0.095	0.082	0.11
$INV_{i,t+1}$	Manufacturing	Retailing	Mining	Tourism
$TQ_{i,t}$	0.001***	0.001*	0.003**	0.002
	(0.000)	(0.001)	(0.001)	(0.001)
$CF_{i,(t+1)}$	0.089***	0.074***	0.072***	-0.000
	(0.005)	(0.015)	(0.018)	(0.027)
$LEV_{i,t}$	-0.004	-0.002	-0.013	-0.029*
	(0.004)	(0.011)	(0.014)	(0.016)
$SIZE_{i,t}$	-0.007***	-0.008***	-0.001	-0.010**
	(0.001)	(0.003)	(0.003)	(0.005)
$NWC_{i,t}$	0.037***	0.013	0.005	0.036**
	(0.003)	(0.011)	(0.011)	(0.014)
$SG_{i,t}$	0.004***	0.005**	0.002	0.006*
	(0.001)	(0.002)	(0.002)	(0.003)
$DDIV_{i,t}$	0.008***	0.005	0.010***	0.008*
	(0.001)	(0.003)	(0.004)	(0.005)
$GDP_{j,t}$	0.015*	0.033	0.146**	0.017
	(0.009)	(0.033)	(0.061)	(0.059)
$PR_{j,t}$	-0.051***	-0.117***	-0.161***	-0.021
	(0.012)	(0.041)	(0.052)	(0.060)
Constant	0.184***	0.245***	0.150***	0.263***
	(0.017)	(0.058)	(0.052)	(0.086)
Firm and Time Effects	Yes	Yes	Yes	Yes
Adjusted R^2	0.11	0.13	0.16	0.083

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.
Robust standard errors clustered at the firm level are presented in parentheses.
Source: Authors' calculations.

Exploring Firm-level Heterogeneities

Corporate investment decisions are closely linked to firm-specific characteristics. Even firms operating in the same country may respond differently to political risk, depending on various factors such as managerial behavior, political connections, and financial structure. For instance, Giambona et al. [73] find that risk-averse managers are more likely to avoid politically risky countries. Political connections have also been shown to mitigate the adverse effects of political risk on investment and cost of capital [18; 72].

Among financial characteristics, factors such as financial flexibility, cash holdings, and asset tangibility are frequently cited as key sources of firm-level heterogeneity in response to uncertainty [5; 35; 45; 51]. As discussed in the theoretical framework (Section 2), these factors respectively reflect a firm's access to external finance, its liquidity buffer, and the degree of investment irreversibility. Based on these distinctions, we re-estimated our main models across subgroups defined by each factor to examine whether the effect of political risk on investment varies across different firm profiles.

Role of Financial Flexibility

Financial flexibility refers to a firm's ability to borrow without experiencing financial distress. Firms that exhibit a positive difference between their unused debt capacity and their actual debt levels are considered financially flexible [6; 74]. Financially flexible firms are less exposed to financial constraints and, consequently, are more capable of undertaking investments. Moreover, they can access external financing more easily when facing growth opportunities [43].

$$LEV_{i,t} = \alpha_1 LEV_{i,t-1} + \beta_1 INDLEV_{i,j,(t-1)} + \beta_2 MTB_{i,t-1} + \beta_3 SIZE_{i,t-1} + \beta_4 TANG_{i,t-1} + \beta_5 INF_{i,t-1} + \\ + firm\ fixed\ effects + time\ fixed\ effects + \varepsilon_{i,t} \quad (2)$$

Table 8. Political risk and corporate investment: Role of financial flexibility

$INV_{i,t+1}$	I (Financially inflexible)	II (Financially flexible)
$TQ_{i,t}$	0.001*** (0.000)	0.001*** (0.000)
$CF_{i,(t+1)}$	0.082*** (0.004)	0.063*** (0.005)
$LEV_{i,t}$	-0.008*** (0.003)	0.003 (0.005)
$SIZE_{i,t}$	-0.005*** (0.001)	-0.010*** (0.001)
$NWC_{i,t}$	0.025*** (0.002)	0.035*** (0.003)
$SG_{i,t}$	0.003*** (0.000)	0.003*** (0.001)
$D\_DIV_{i,t}$	0.008*** (0.001)	0.003*** (0.001)
$GDP_{j,t}$	0.072*** (0.012)	-0.002 (0.008)
$PR_{j,t}$	-0.013 (0.011)	-0.057*** (0.014)
Constant	0.145*** (0.013)	0.231*** (0.021)
Firm and time effects	Yes	Yes
Adjusted R^2	0.093	0.085
Sample count	87.018	48.561

*** p < 0.01, ** p < 0.05, * p < 0.1.
Robust standard errors clustered at the firm level are presented in parentheses.
Source: Author's computations.

Following prior literature, we employed the model presented in Equation 2, where subscripts *i, t, j,* and l denote firm, time, sector, and country, respectively, to classify the sample based on financial flexibility. *LEV* represents firm leverage; *IND_LEV,* the industry-average leverage; *MTB,* the market-to-book ratio; *SIZE,* firm size; *TANG,* the ratio of fixed assets to total assets; and *INF,* the consumer price index. First, we estimated Equation 2 using a two-way fixed effects model to measure predicted leverage levels. Then, we calculated the deviation between actual and predicted leverage. Firms that had a positive deviation for at least three consecutive years were classified as financially flexible [75; 76]. We referred to the other firms as financially inflexible.

Table 8 presents the findings based on the adjusted sample of financially flexible firms. The analysis in Column I corresponds to financially inflexible firms, while Column II pertains to financially flexible firms.

The relationship between *PR* and *INV* is significantly negative for financially flexible firms. In contrast, the *PR–INV* relationship is not statistically significant for firms operating without financial flexibility. These results suggest that, although financially flexible firms have access to borrowing, they may still cancel or postpone investment decisions in the presence of political risk. This indicates that financial flexibility does not necessarily mitigate the adverse effects of political risk. This finding is also consistent with the study that examines the role of financial flexibility in the context of political risk [75]. Based on the findings for the two groups, Hypothesis 1d is not supported.

The results for the *CF–INV* and *LEV–INV* relationships are consistent with theoretical expectations. Cash flow sensitivity is greater for financially inflexible firms, as they lack borrowing capacity. Moreover, the *CF–INV* relationship shows a higher coefficient for financially inflexible firms, highlighting the greater importance of internal funds for these firms. While the *LEV–INV* relationship is not significant for financially flexible firms, it has a significantly negative effect on financially inflexible firms.

Role of Cash Holdings

Companies need funds to finance their investments. Financial constraints limit access to external funding and increase firms' sensitivity to internal cash flows. Cash holdings can reduce dependence on external financing and lower this sensitivity. Moreover, political risk may lead to a higher cost of debt and constrain firms' cash flows [6]. To examine these arguments, we estimated the main regression model across subsamples grouped by firms' levels of cash holdings. The findings are presented in Table 9.

Table 9. Political Risk and Corporate Investment: Role of Cash Holdings

$INV_{i,t+1}$	Low Cash	Middle Cash	High Cash
$TQ_{i,t}$	0.001***	0.002***	0.001***
	(0.000)	(0.000)	(0.000)
$CF_{i,(t+1)}$	0.073***	0.089***	0.055***
	(0.009)	(0.007)	(0.006)
$LEV_{i,t}$	-0.013**	-0.009*	0.003
	(0.005)	(0.005)	(0.006)
$SIZE_{i,t}$	-0.010***	-0.007***	-0.008***
	(0.002)	(0.001)	(0.001)
$NWC_{i,t}$	0.030***	0.017***	0.038***
	(0.005)	(0.005)	(0.005)
$SG_{i,t}$	0.003***	0.003***	0.004***
	(0.001)	(0.001)	(0.001)
$D\_DIV_{i,t}$	0.008**	0.005***	0.005***
	(0.001)	(0.001)	(0.001)
$GDP_{j,t}$	0.034**	0.036***	0.015
	(0.014)	(0.013)	(0.011)
$PR_{j,t}$	-0.049**	-0.025	-0.024
	(0.021)	(0.017)	(0.017)
Firm and Time Effects	Yes	Yes	Yes
Adjusted R^2	0.07	0.08	0.07

*** p < 0.01, ** p < 0.05, * p < 0.1.
Robust standard errors clustered at the firm level are presented in parentheses.
Source: Author's computations.

The findings indicate that cash holdings mitigate the negative effect of political risk on corporate investment. The *PR–INV* relationship is statistically significant in the low-cash sample, but not in the others. The results are consistent with the existing literature [16; 35]. In light of these findings, Hypothesis "1" _"e" cannot be rejected.

Additionally, Cash flow sensitivity is similar in the low- and middle-cash samples, yet it is remarkably lower in the high-cash sample. Finally, a notable difference is observed in the relationship between LEV and INV. While this relationship is negative in the low- and middle-cash samples, it is not statistically significant in the high-cash sample.

Role of Tangibility

Tangibility, the ratio of fixed assets to total assets, is also associated with investment irreversibility. Higher tangibility may lead to greater sunk costs when firms attempt to reverse investments in response to risks. In contrast, firms with lower tangibility are more flexible in managing their investments and are less likely to cancel or postpone them [6; 35].

An alternative perspective argues that fixed assets enhance firm credibility and facilitate access to external financing due to their pledgeability. This, in turn, mitigates financial constraints and reduces sensitivity to internal cash flows [41]. To examine the role of tangibility in the relationship between political risk and corporate investment, we estimated the main models for subsamples categorized according to their levels of tangibility. The results are presented in Table 10.

The negative effect of political risk on corporate investment increases with the level of tangibility. These findings support the investment irreversibility perspective discussed above. Moreover, the stronger *CF–INV* relationship observed in the high-tangibility subsample suggests that the alternative view based on pledgeability may not be valid for emerging markets. The result is parallel to existing literature [41; 77]. Considering the findings, Hypothesis 1f cannot be rejected.

Conclusion

This study examines how political risk affects corporate investment in emerging markets. The findings reveal significant heterogeneity in the relationship between political risk and corporate investment, both across countries and at the firm level. While political risk has a negative impact on corporate investment in countries with high political risk, the relationship is not statistically significant in coun-

Table 10. Political Risk and Corporate Investment: Role of Tangibility

$INV_{i,t+1}$	Low Tangibility	Middle Tangibility	High Tangibility
$TQ_{i,t}$	0.000** (0.000)	0.001*** (0.000)	0.002*** (0.000)
$CF_{i,(t+1)}$	0.050*** (0.005)	0.076*** (0.005)	0.095*** (0.007)
$LEVi_{,t}$	0.000 (0.004)	0.000 (0.005)	-0.005 (0.005)
$SIZE_{i,t}$	-0.005*** (0.001)	-0.008*** (0.001)	-0.013*** (0.001)
$NWC_{i,t}$	0.025*** (0.003)	0.049*** (0.004)	0.046*** (0.005)
$SG_{i,t}$	0.001** (0.000)	0.004*** (0.001)	0.004*** (0.001)
$D\_DIV_{i,t}$	0.004*** (0.001)	0.006*** (0.001)	0.007*** (0.001)
$GDP_{j,t}$	0.014 (0.009)	0.020* (0.010)	0.030** (0.013)
$PR_{j,t}$	-0.011 (0.011)	-0.025* (0.013)	-0.054*** (0.017)
Firm and time effects	Yes	Yes	Yes
Adjusted R^2	0.06	0.09	0.11

*** p < 0.01, ** p < 0.05, * p < 0.1.
Robust standard errors clustered at the firm level are presented in parentheses.
Source: Author's computations.

tries with lower levels of political risk. Firms' responses to political risk vary depending on the specific type of risk involved. Firm-level characteristics such as industry affiliation, financial flexibility, cash holdings, and asset tangibility also moderate the impact of political risk on corporate investment. The results are consistent with prior literature [5; 33; 35–37; 42; 70–72]. The findings of this study are more robust than those of earlier research due to its broad cross-country coverage, use of firm-level data, and disaggregation of political risk by type. These features distinguish it from previous studies.

The findings show the difference in investment and political risk mechanism because of the home countries' political environment and firm-level factors as cash holding and tangibility. They support the previous research and also emphasize the political risk management policy that should be adopted with regard to home countries and above-mentioned financial factors [16; 35; 41; 77].

Survey-based research in the existing literature shows that companies rarely incorporate political risk into the capital budgeting process [78; 79]. Our findings, however, indicate that political risk significantly affects corporate investment decisions, especially in countries with high levels of political instability. Financial managers should consider political risk and its various dimensions when making capital budgeting decisions. The results also underline the important role of cash holdings and the tangibility ratio. While the theoretical framework remains closely tied to investment policy [80], our findings suggest that cash assets can mitigate the negative effects of political risk. Firms are advised to manage their cash reserves strategically in line with their exposure to such risks. Additionally, investment irreversibility should not be overlooked. Political risk has a greater impact on firms with higher levels of asset tangibility, which supports the application of the real options theory and a "wait-and-see" approach to avoid significant sunk costs in politically unstable environments.

The study sample includes firms from 21 emerging markets over the period from 2001 to 2021. The study offers a comprehensive examination of the relationship between political risk and corporate investment, covering an extensive sample of emerging markets over two decades. The study has certain limitations. First, no alternative index as comprehensive as the ICRG was identified. As a result, ICRG ratings serve as proxy for political risk, and the robustness of the findings could not be tested using other indicators. Second, potential endogeneity concerns remain. Although dynamic panel regression techniques such as system GMM and difference GMM were employed, the validity of the instrumental variables could not be confirmed, and the related results are not reported. These limitations present opportunities for future research to extend and validate the current findings. The analysis also addresses firm-level heterogeneity in terms of financial flexibility, cash holdings, and asset tangibility. Other relevant dimensions discussed in the literature, such as the behavioral traits of top management [73] and political connections [18; 72], were not included. Incorporating these factors may enhance future research, particularly in the context of emerging markets.

The findings of the study highlight the significance of political structures in emerging markets and their impact on the economy. While political risk negatively affects corporate investment in countries with high political risk, firms in low-risk countries are not significantly affected. Governments should build strong political systems, enhance bureaucratic quality, prioritize the rule of law, and foster a conducive business environment, particularly in countries facing high levels of political risk. The results also emphasize the importance of effective cash management and investment reversibility in mitigating the adverse effects of political risk.

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Appendix 1. Number of Firms in the Sample by Country

Country	Firms	Country	Firms	Country	Firms
Brazil	375	**South Africa**	193	**Indonesia**	720
Egypt	197	**The United Arab Emirates**	71	**India**	4207
South Korea	2488	**Malaysia**	942	**Mexico**	116
Poland	640	**Russia**	248	**Saudi Arabia**	193
Taiwan	2014	**Kuwait**	93	**Peru**	103
Chile	144	**China**	5146	**Turkiye**	420
Greece	125	**Thailand**	805	**Philippines**	224

Source: Constructed by the authors using the article dataset.

Appendix 2. Stationary Tests

	Constant		Constant and Trend	
Variables	**ADF**	**PP**	**ADF**	**PP**
INV	102524 (0.0000)	114977 (0.0000)	76525.9 (0.0000)	98280.6 (0.0000)
TQ	74236.2 (0.0000)	82987.0 (0.0000)	53047.1 (0.0000)	67096.2 (0.0000)
CF	76076.5 (0.0000)	82817.3 (0.0000)	64787.6 (0.0000)	81665.5 (0.0000)
LEV	61734.5 (0.0000)	60541.1 (0.0000)	50281.2 (0.0000)	53598.1 (0.0000)
SIZE	60364.7 (0.0000)	79399.4 (0.0000)	44450.7 (0.0000)	50927.9 (0.0000)
NWC	195422 (0.0000)	195271. (0.0000)	167880. (0.0000)	167880. (0.0000)
SG	115003. (0.0000)	148273. (0.0000)	88658.0 (0.0000)	144941. (0.0000)
D_DIV	23947.5 (0.0000)	72349.8 (0.0000)	20356.0 (0.0000)	52817.7 (0.0000)
GDP	133569. (0.0000)	132472. (0.0000)	142388. (0.0000)	212868. (0.0000)
PR	63034.9 (0.0000)	52204.5 (0.0000)	69190.2 (0.0000)	71252.8 (0.0000)
		H0		

H0: Panels contain a unit root.
P-values are presented for each variable in parentheses. According to the test results, all panels are stationary.
Source: Author's computations.

Appendix 3. Descriptive Statistics

Variables	Pooled Sample	Brazil	Chile	China	Egypt	Greece	India	Indonesia	South Korea	Kuwait	Malaysia
N	409.731 (100.0%)	7.875 (1.9%)	3.024 (0.7%)	108.066 (26.4%)	4.137 (1.0%)	2.625 (0.6%)	88.347 (21.6%)	15.120 (3.7%)	52.248 (12.8%)	1.953 (0.5%)	19.782 (4.8%)
INV	0.066 (0.088)	0.062 (0.079)	0.052 (0.058)	0.076 (0.086)	0.044 (0.076)	0.041 (0.064)	0.070 (0.100)	0.068 (0.099)	0.071 (0.091)	0.043 (0.080)	0.047 (0.070)
TQ	2.130 (3.137)	1.555 (2.454)	1.261 (2.102)	2.975 (3.192)	2.179 (3.687)	1.204 (1.160)	2.277 (3.696)	2.015 (3.167)	1.456 (1.732)	1.239 (0.892)	1.610 (2.671)
CF	0.084 (0.119)	0.070 (0.127)	0.083 (0.097)	0.098 (0.107)	0.083 (0.113)	0.050 (0.093)	0.078 (0.116)	0.084 (0.128)	0.064 (0.132)	0.071 (0.116)	0.071 (0.114)
LEV	0.473 (0.259)	0.666 (0.329)	0.460 (0.221)	0.441 (0.221)	0.495 (0.267)	0.585 (0.261)	0.554 (0.314)	0.564 (0.305)	0.449 (0.234)	0.423 (0.228)	0.409 (0.234)
SIZE	18.670 (1.890)	20.011 (2.017)	19.500 (2.382)	19.587 (1.494)	18.011 (1.787)	18.619 (1.720)	17.559 (2.054)	18.463 (1.865)	18.692 (1.597)	19.373 (1.338)	18.241 (1.633)
NWC	0.199 (0.265)	0.113 (0.276)	0.116 (0.179)	0.219 (0.268)	0.190 (0.257)	0.128 (0.248)	0.182 (0.282)	0.123 (0.293)	0.193 (0.259)	0.135 (0.263)	0.232 (0.250)
SG	0.179 (0.606)	0.151 (0.569)	0.112 (0.538)	0.232 (0.531)	0.133 (0.669)	0.078 (0.453)	0.173 (0.691)	0.190 (0.672)	0.168 (0.573)	0.173 (0.789)	0.136 (0.592)
DDIV	0.656 (0.475)	0.825 (0.380)	0.922 (0.268)	0.592 (0.492)	0.651 (0.477)	0.663 (0.473)	0.631 (0.482)	0.597 (0.490)	0.657 (0.475)	0.675 (0.469)	0.729 (0.445)
GDP (%)	5.757 (3.580)	2.176 (2.975)	3.638 (3.442)	8.690 (2.484)	4.205 (1.542)	0.098 (4.918)	6.123 (3.152)	4.854 (1.708)	3.668 (1.855)	2.801 (6.062)	4.303 (2.922)
PR	33.246 (8.093)	34.315 (2.151)	23.698 (2.915)	37.071 (4.830)	42.006 (4.742)	26.837 (4.163)	39.018 (2.450)	42.700 (3.595)	22.760 (1.307)	28.581 (4.346)	27.688 (2.368)

Appendix 3. Descriptive Statistics (Continued)

Variables	Mexico	Peru	Philippines	Poland	Russia	Saudi Arabia	South Africa	Taiwan	Thailand	Turkiye	United Arab Emirates
N	2.436 (0.6%)	2.163 (0.5%)	4.704 (1.1%)	13.440 (3.3%)	5.208 (1.3%)	5.040 (1.2%)	4.053 (1.0%)	42.294 (10.3%)	16.905 (4.1%)	8.820 (2.2%)	1.491 (0.4%)
INV	0.059 (0.064)	0.056 (0.068)	0.052 (0.086)	0.072 (0.102)	0.064 (0.078)	0.068 (0.094)	0.060 (0.070)	0.054 (0.079)	0.067 (0.089)	0.058 (0.088)	0.053 (0.076)
TQ	1.423 (1.541)	0.864 (0.839)	2.366 (4.105)	2.183 (3.572)	1.244 (0.906)	4.152 (6.610)	1.621 (1.939)	1.551 (1.438)	1.647 (2.129)	4.931 (7.849)	1.355 (1.663)
CF	0.085 (0.076)	0.108 (0.120)	0.067 (0.127)	0.085 (0.166)	0.097 (0.116)	0.115 (0.122)	0.113 (0.123)	0.085 (0.115)	0.102 (0.121)	0.082 (0.129)	0.088 (0.113)
LEV	0.523 (0.218)	0.420 (0.195)	0.479 (0.323)	0.499 (0.268)	0.507 (0.299)	0.397 (0.225)	0.512 (0.235)	0.417 (0.185)	0.453 (0.264)	0.515 (0.285)	0.405 (0.249)
SIZE	20.847 (1.434)	18.895 (1.796)	18.513 (2.226)	17.423 (2.073)	18.684 (1.921)	19.692 (1.642)	19.666 (1.987)	18.494 (1.515)	18.247 (1.615)	18.468 (1.777)	20.241 (1.652)
NWC	0.126 (0.203)	0.114 (0.188)	0.126 (0.306)	0.180 (0.273)	0.135 (0.269)	0.143 (0.210)	0.136 (0.218)	0.284 (0.223)	0.160 (0.266)	0.153 (0.266)	0.149 (0.239)
SG	0.113 (0.413)	0.117 (0.454)	0.214 (0.836)	0.248 (0.817)	0.095 (0.481)	0.142 (0.539)	0.149 (0.564)	0.161 (0.585)	0.164 (0.606)	0.132 (0.692)	0.156 (0.602)
DDIV	0.696 (0.460)	0.796 (0.403)	0.592 (0.492)	0.422 (0.494)	0.503 (0.500)	0.748 (0.434)	0.798 (0.402)	0.789 (0.408)	0.742 (0.438)	0.444 (0.497)	0.721 (0.449)
GDP (%)	1.346 (3.323)	4.536 (4.535)	4.822 (3.536)	3.691 (2.135)	3.244 (3.889)	3.261 (3.994)	2.286 (2.565)	4.01 (5.77)	3.356 (3.069)	5.005 (4.474)	3.419 (3.850)
PR	32.405 (4.981)	36.181 (1.780)	36.968 (2.179)	22.913 (1.821)	38.681 (3.986)	32.248 (2.011)	33.813 (2.404)	21.752 (1.826)	39.973 (5.862)	42.450 (5.150)	22.677 (1.340)

*In line N, the values in parentheses indicate each country's share in the total sample, while the values outside the parentheses represent the number of observations for each country.
** In the other rows, the values in parentheses indicate each variable's mean, while the values outside the parentheses represent the standard deviation.
Source: Constructed by the authors using the article dataset.

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