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Contents

Journal of Corporate Finance Research
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New Research

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Board Committee Diversity and Its Effects on Financial Performance: A Study of Russian Firms

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Abstract

As one of the key elements of corporate financial architecture, corporate governance significantly affects corporate performance. However, academic papers focusing on board characteristics rarely analyze the composition of board committees, while a specific Russian regulatory and corporate environment limit an applicability of results obtained for foreign samples. This study aims to bridge these gaps by analyzing the effects of composition of key board committees on market-based indicators of financial performance of the 100 largest Russian public non-financial companies over an 8-year period from 2014 to 2021. The results of panel data analysis indicate that the professional experience diversity of members of audit, strategy and sustainability committees significantly affects Tobin's Q and total shareholder return (TSR); moreover, the effects of experience diversity are stronger than the effects of board committee size, independence, and educational diversity. I also find that powerful CEOs can weaken the positive effects of board committee composition on corporate performance or, vice versa, mitigate some negative effects, which is in line with some previous findings. In addition to academic contribution, this study offers valuable insights for practical application while analyzing changes in corporate governance structure of Russian companies, which is especially important in the context of the massive transformations taking place since February 2022.

Keywords: corporate governance, board of directors, board committees, CEO power, corporate financial performance, resource-based theory

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Introduction

Corporate governance, being one of three elements of corporate financial architecture [1], significantly affects mechanisms of making key decisions about business models and investing and financing activities and, as a result, determines corporate financial performance and company value. The board of directors, as the supreme body in the corporate governance structure, performs a *monitoring* function by controlling the activity of the senior management team and the CEO and ensuring disclosure quality and an *advisory* function by analyzing corporate performance and position in the industry and offering shareholders ideas for further company development. While performing these functions, the board needs to balance the interests of shareholders, management and other internal and external stakeholders [2]. As a result, board characteristics significantly affect corporate performance in both developed and emerging markets, including Russia [3–8].

Although many papers have contributed to the investigation of the impact of different board characteristics on corporate financial performance, there are several gaps in the academic literature. Firstly, most papers focus on overall board composition characteristics, while only a limited number of authors investigate the effects of board committee characteristics on corporate performance. Secondly, while different aspects of corporate governance are widely studied for the US, UK, Canada and EU countries, there is only a limited number of publications devoted to emerging markets (except China). At the same time, emerging economies have not only increased their share in the global GDP during the last decades but also feature specific institutional environments, limiting the applicability of results obtained for developed markets. For example, board size, independence, gender diversity and multiple directorship are significantly lower in Russia than in developed countries and some emerging ones, while the presence of foreign board members and board activity are relatively high [6]. Additionally, due to such features of the corporate sector in Russia as ownership concentration, controlling shareholders' and managers' power, and relatively poor protection of minority shareholders' rights, boards tend to play an *advisory* than a *monitoring* (controlling) role [4]. Thirdly, while many existing papers consider CEO power as a significant determinant of corporate performance, some of the most widely applied indicators of CEO power are not applicable to the Russian case (CEO duality) or can be hardly applied due to the lack of relevant information (CEO remuneration structure).

This paper aims to fill these gaps by analyzing the impact of various characteristics of the composition and diversity of audit, strategy, and sustainability board committees. It contributes to the existing literature by providing comprehensive evidence based on an analysis of the 100 largest Russian corporations listed on the Moscow Stock Exchange from 2014 to 2021. The results demonstrate that the professional expertise diversity of audit, strategy, and sustainability board committees affects corporate financial performance more significantly than board committee composition and educational diversity, which is in line with recent findings for emerging markets [9–11]. Secondly, I demonstrate that CEO power negatively moderates these effects with the help of an integrated indicator based on several CEO characteristics, which can be used for further research in the Russian context. The negative effects of CEO power due to the board's limited ability to perform *monitoring* and *advisory* roles has been demonstrated in previous papers focusing on the impact of corporate governance on corporate performance [8; 12; 13]. In addition to their academic relevance, these findings can be applied in practice by shareholders and consulting agencies looking for candidates for corporate boards and by market analysts studying Russian public companies.

To contextualize the study within the broader field, I first examine the existing body of research devoted to the impact of board characteristics, board committees and CEO power on corporate financial performance. In subsequent sections, I formulate the hypotheses and present the methodology and results of my empirical research, interpreting them on the basis of the literature review. In the final section, I summarize the applicability of the obtained results for business practitioners and policy makers and identify perspective directions for further research.

Literature Review

Most of the papers studying the impact of corporate governance characteristics on corporate performance focus on the board of directors (board) as the supreme governing body and the chief executive officer (CEO) as the supreme executive. Researchers highlight two key roles played by boards that affect corporate performance: their *monitoring* (or *supervisory*) and *advisory* functions.

Many existing papers focus on the board's ability to perform a *monitoring* (or *supervisory*) function, controlling and evaluating executives' activities and preventing or mitigating *agency conflicts* appearing due to the opportunistic behavior of top managers. This approach is in line with agency theory formulated by Jensen and Meckling [14]. Researchers who analyze the effects of board composition on corporate performance from this perspective claim that board independence improves corporate governance quality by enhancing the board's ability to perform its monitoring function, allowing it to protect shareholder rights more efficiently [10; 15–18]. Mitigating the agency conflict, independent board members contribute to overall a company's performance by increasing its investment attractiveness [19; 20], reducing the cost of capital [21] and enhancing the quality of corporate financial and non-financial disclosure [11]. However, these positive effects may be weakened by the higher busyness of independent directors and, as a result, their lack of time to consider all issues efficiently [22].

Another point of view is presented by *stakeholder theory*. According to this approach formulated by Robert Edward Freeman [23], a company should not only meet the interests of financial stakeholders (shareholders and debt hold-

ers), but also identify and balance the interests of a broader range of stakeholders (such as employees, suppliers, consumers, local communities, etc.). Along with the board's *monitoring* role, researchers consider its *advisory* roles [24] in the development of firm strategy, defining priorities, addressing strategic issues, etc. A number of authors claim that the board's capability to perform these functions improves company financial performance and value creation [25–31]. Researchers consider board members' independence [31–32], gender diversity [33–35] and national diversity [16] as positive factors, which allow them to take the interests of a broader range of stakeholders into account when making decisions. A more diversified board represents a broader range of points of view [36–37], leading to more efficient information processing and decision making. However, these effects may be diluted in the case of a low level of representation of female directors on the board [38]. Moreover, many authors argue that it is more important to evaluate unique resources – expertise, social ties, reputation – provided by board members [28; 30; 39–40] and their participation in board committees [41].

As boards need to address a broad range of issues from day-to-day business to strategic planning, board members need a wide range of knowledge and competencies to perform both monitoring and advisory roles. Thus, in recent decades a growing number of researchers have considered board characteristics from the perspective of *resource-based theory* (or a *resource-based view*). According to this approach, a company's resilience, performance and value depend on its access to unique resources such as technologies, knowledge, skills, information, etc. [42]. Following this concept, Hillman and Dalziel [25] coined the term *board capital*, which includes the human capital (knowledge, professional skills and experience) and the social capital (professional ties and reputation) of board members. Boards with diversified human capital mitigate the negative effects of board dependency (higher share of executives, CEO duality) [27] and contribute to company innovativeness [43]. Such boards also determine company strategy, actively consulting CEOs [44] and controlling managers' performance more effectively [45]. In line with this point of view, some researchers have underlined that higher board independence contributes to better monitoring quality only in the case of sufficient specialized knowledge and skills [46–47]. Foreign board members also contribute to the higher efficiency of monitoring and decision-making processes by bringing new knowledge and practices of corporate governance [48–49] as well as professional ties and reputation among foreign stakeholders [48; 50], which is especially important for emerging markets. Additionally, domestic board members with an experience of studying or working abroad also bring new knowledge and values affecting decisions made by the board [30]. However, it is noteworthy that the contribution of foreign directors to corporate performance is more significant in the case of sufficient firm-specific knowledge and experience [16; 30; 40]. Additionally, the positive effects of human and social capital provided by foreign board members may be undermined due to the latter's greater busyness and lack of communication and coordination [51–52].

Several papers have evaluated the effects of board members' human capital by analyzing their educational background [16; 53–54] and professional experience [11; 53; 55–57]. Educated directors contribute to better board monitoring performance [33; 58]; moreover, directors' educational background significantly affects their values and, as a result, their approach to the company's strategic development [30; 54; 59]. However, a possible drawback of board members' educational diversity is the segmentation among directors and the difficulty of communication, lowering board efficiency [16]. Some authors such as Fedaseyeu et al. [55] claim that professional skills and knowledge are the most significant determinants of the director's role in the board. Specialized professional experience of board members in finance and audit enhances monitoring quality [60] and the efficiency of investing activity [53]. Wang [57], considering board expertise diversity in S&P 1500 companies, claims that the level of expertise diversity has a non-linear positive impact on the implementation of new approaches, practices and technologies (innovations): on the one hand, boards with expertise diversity aggregate a wide range of unique knowledge and skills yet, on the other hand, internal conflicts and communication problems appear.

Another dimension of board members' expertise is firm-specific and industry-specific experience. Many researchers use board tenure as a proxy for these factors [10; 54; 61]. However, the effects of board members' tenure are non-linear: on the one hand, new board members provide the company with new skills, as they are less biased and give their colleagues a new perspective on the company; on the other hand, longer-tenured directors are better informed about firm-specific issues [62]. As a result, there is evidence that board members' tenure diversity and industry-specific experience contribute to corporate performance by improving monitoring quality [63], investing efficiency [64] and overall financial performance [10].

Although most authors focus on overall board composition characteristics, some papers study the effects of board committee characteristics on corporate performance. The audit committee is the most widely studied as its members monitor the quality of financial and non-financial reporting and provide the necessary financial expertise for efficiently monitoring the company's financial results. Researchers have found that a higher level of audit committee independence and activity (i.e., a higher frequency of committee meetings) enhances monitoring quality and, as a result, the company's transparency and performance [11; 37; 65–67]. Additionally, the professional experience of audit committee members in finance and audit contributes to both corporate accounting-based and market-based financial performance [60; 65]. As for other board committees, many researchers have focused in recent years on the effects of the sustainability committee. However, they have mostly considered the impact of sustainability committee composition on corporate non-financial performance

and disclosure [35; 68–70]. At the same time, members of the sustainability committee also provide the company with unique knowledge and experience, which may affect its financial performance. Additionally, according to results obtained by Eberhardt-Toth [68] for the sustainability committee, such characteristics as committee size and independence also significantly affect its effectiveness. Supporting these findings, Jarboui et al. [70] show that the effectiveness of board sustainability committee is significantly affected by its members' academic background and professional experience.

While the board of directors is widely investigated as the supervisory governing body, many authors analyze the characteristics of the CEO as the top executive implementing strategies offered by the board and determining corporate performance. According to the *upper echelons theory* formulated by Hambrick and Mason [71], the CEO's personal values, cognitive style, knowledge and experience significantly affect strategic decisions and, as a result, corporate performance [72–74]. At the same time, most researchers include CEO power in their models as a factor affecting the board's ability to perform its monitoring function and moderating the effects of the board advisory function. For example, Baldenius et al. [24] distinguish two models: centralization, with decisions made mostly by the board, and delegation, with greater CEO power yet with a strong board monitoring function. They demonstrate that a powerful CEO can implement investment decisions more quickly and effectively than the board in the centralization model yet that the CEO's biases can harm company performance. This is in line with results obtained for several emerging countries [34; 75–76].

Most researchers consider the effects of CEO power on corporate governance quality and corporate performance from the *agency theory* perspective, claiming that greater CEO power is a negative factor which broadens the CEO's ability to deter the board's monitoring function [8; 64; 77–79]. For instance, Merendino and Melville [22], finding a negative impact of CEO duality on the accounting-based financial performance (ROA) of Italian public companies, assume that powerful CEOs mitigate the positive effects of board composition and determine board composition in line with their personal interests. A similar effect of the increase in the power of the CEO over the board has been found in the Russian case [8].

To assess CEO power, most authors include CEO duality (i.e., a single person combining CEO and board chairperson roles) in their models [10; 11; 64; 66; 76; 80]. However, this parameter is not relevant to the Russian case, as the Russian Corporate Governance Code does not allow CEO duality. Another way to measure CEO power is to consider CEO compensation and ownership. For example, Park et al. [81] find that a higher level of CEO ownership strengthens the negative effects of CEO hubris on the corporate performance of Korean public companies, arguing that powerful and arrogant CEOs may invest corporate resources into promoting their personal brand, decreasing the overall quality of corporate governance. Muravyev et al. [82] do not find a significant impact of CEO ownership and tenure on corporate financial performance as measured by ROA, ROE, Tobin's Q, and PBC (private benefits of control). At the same time, they show that companies governed by CEOs only (without a board of directors) demonstrate poorer performance, which may indicate the need for curbing CEO power.

Finally, some authors use complex CEO power indices, including the CEO's role on the board (CEO duality and/or participation in board committees) as well as CEO remuneration, ownership and tenure. A case in point is the study by Velte [83] that analyzes the moderating effect of CEO power on the relation between the corporate ESG (Environmental, Social, and Governance) rating and financial performance. Using an integrated CEO power index including CEO pay slice, CEO ownership and CEO tenure for a sample of German public companies, the author demonstrates that powerful CEOs enhance the positive impact of a higher ESG rating on both corporate accounting-based (ROA, ROE) and market-based (Tobin's Q) performance indicators. However, it is noteworthy that, in Germany, the board monitoring function is strictly determined by legislation. Additionally, operating in the regulatory environment of the civil law system, German companies have to be more stakeholder-focused than companies operating in common law countries, such as the US and the UK. These findings demonstrate that powerful CEOs can contribute to corporate performance by implementing board decisions more effectively thanks to effective control. However, Zavertiaeva and Ershova [8] and Nurgozhaeva [84] have shown that this is not the case in Russia.

To sum up, despite the plethora of studies devoted to the effects of board characteristics and CEO power on financial performance, there exist several considerable research gaps. Firstly, most researchers focus on widespread board parameters such as board independence, gender, national diversity and generational diversity, paying less attention to board members' education and professional experience. Secondly, even when researchers include such parameters, they largely consider only certain types of education (members with MBA or postgraduate degrees or majors in particular fields) and professional experience (industry-specific experience, experience related to corporate sustainability, etc.), rarely examining human capital diversity. Thirdly, as mentioned above, existing literature tends to treat board committees as homogenous entities, neglecting the differences in the roles of various committees and, as a result, the different effects of their members' characteristics. Moreover, few studies have made an in-depth analysis of the composition of board committees. Some papers study the composition of audit committees [11; 37; 65] yet only consider a limited number of characteristics, such as members' independence and financial expertise and the number of meetings. Finally, although many papers investigate the effects of CEO power on corporate performance, few of them analyze its moderating role on the impact of board characteristics. I aim to bridge these gaps by examining a broad range of characteristics of board committees

in the largest Russian public non-financial companies and their correlation with corporate financial performance, along with the moderating effect of CEO power on this correlation.

Hypotheses

The review of existing literature highlights gaps in our understanding of the impact of board committee characteristics in emerging markets, including Russia. Based on these insights, I propose the following hypotheses to guide our investigation.

H1. A higher board committee independence level, ceteris paribus, enhances corporate financial performance.

In line with *agency theory*, independent directors strengthen the board's monitoring role, while, according to *resource-based theory*, independent directors bring unique experience, knowledge and social ties [9; 66]. Some papers also demonstrate the positive impact of the independence of board audit and sustainability committees on corporate performance [37; 68].

H2. Greater board committee tenure diversity, ceteris paribus, enhances corporate financial performance.

According to previous results [63], it is necessary to reach a "trade-off" between the new views and expertise provided by newly appointed board members [62] and the firm-specific knowledge and skills of tenured directors [57]. As a result, boards that are more diversified in terms of tenure perform both advisory and monitoring functions more efficiently.

H3. A higher share of foreign directors in board committees, ceteris paribus, enhances corporate financial performance.

I consider the role of foreign board members from the *resource-based theory* perspective [16; 49] by assuming that they provide the company with unique knowledge, skills and best practices of corporate governance. As a result, I assume that foreign directors contribute to the overall human capital of board committees.

H4. A higher level of board committee education diversity, ceteris paribus, enhances corporate financial performance.

In accordance with previous studies [33; 54; 58], I assume that board members' diversity in terms of education attainment (undergraduate, graduate, MBA, academic degrees) and major (economics, finance, technical fields, law, humanities) contributes to financial performance.

H5. The diverse professional expertise of board committees, ceteris paribus, enhances corporate financial performance.

Based on the results of existing studies [5, 44, 57, 85–86], I assume that the presence of members with diversified expertise (finance and audit, technical services, public service, CEO-level expertise) in board committees enhances corporate financial performance.

H6. A higher level of CEO power, ceteris paribus, moderates the positive effects of board committee human capital on financial performance.

I assume that a higher level of CEO power has a negative impact due to a weaker board monitoring function [12, 22] and a higher CEO ability to negatively affect decision-making processes in the board in order to pursue short-term goals [13], in line with *agency conflict theory*. Following the results of Hayness and Hillman [44], I assume that a powerful CEO moderates the effects of board committee characteristics.

The next section describes the empirical approach used to test these hypotheses.

Sample and Methodology

In order to test the hypotheses formulated above, I analyze a sample of the 100 largest Russian public non-financial companies listed on the Moscow Stock Exchange over the 8-year period from 2014 to 2021. Despite the limited sample, all these companies are among the Top-100 Russian companies in terms of market capitalization. Focusing on the largest companies ensures that the findings are reflective of organizations that have a significant impact on the Russian economy. Additionally, these companies maintain a relatively high level of disclosure related to corporate governance issues, providing information about board and committee composition and characteristics of members required for rigorous analysis. I analyze the period before 2022 due to the drastic changes of financial indicators and market-based indicators of the largest Russian companies in 2022 caused by massive sanctions, which would reduce the explanatory power of regressions.

Regarding the analytical techniques, this study employs a combination of approaches to panel data analysis. Descriptive statistics provide an initial overview of the data, enabling the identification of patterns and trends within the sample. I use GLS (generalized least-square) random-effect and OLS (ordinary least-square) fixed-effect estimators at the first stage of econometric modelling. Then I apply two-step GMM (Generalized Method of Moments) Arellano-Bond dynamic panel-data estimators in order to address potential endogeneity issues and provide robust estimates of the impact of board committee characteristics on corporate financial performance. This method is particularly suited to the panel data structure of the study, allowing for dynamic analysis over the eight-year period. As this method is widely applied in corporate governance research, the methodology is both rigorous and aligned with current academic standards [18; 22; 87].

I use two market-based indicators of corporate performance. Firstly, Tobin's Q calculated as

$$TobinsQ_{it} = (MarketCap_{it} + TotalDebt_{it}) / TotalAssets_{it}$$

This indicator evaluates the efficiency of the usage of company assets to create value for both shareholders and debtholders. According to previous research, both board composition and human and social capital significantly affect Tobin's Q [9; 11; 34; 77; 88], and I assume that board committee characteristics also significantly affect this indicator.

Secondly, I use Total Shareholder Return (TSR) indicators calculated as

$$TSR_{it} = (PriceEnd_{it} - PriceBeg_{it} + Dividends_{it}) / PriceBeg_{it}.$$

This indicator helps to evaluate corporate performance for shareholders in year *t*.

I analyze the sample by building regressions using the following specifications:

(M1) $Fin\_Perf_{it} = \beta_0 + \Sigma \beta_k \times BoardComCharacteristics_{it} + \Sigma \beta_j \times Firm\_Parameters_{it} + IndustryEffects + YearEffects + \varepsilon_{it}$,

k from 1 to 11, j from 12 to 23;

(M2) $Fin\_Perf_{it} = \beta_0 + \Sigma \beta_k \times BoardComCharacteristics_{it} \times (1 - CEO\_Power_{it}) + \Sigma \beta_j \times Firm\_Parameters_{it} + IndustryEffects + YearEffects + \varepsilon_{it}$,

k from 1 to 11, *j* from 12 to 23.

The variables' descriptions are given in Appendix 1.

Results

Descriptive statistics

Table 1 presents the descriptive statistics of the sample in terms of corporate governance – CEO power and board committee characteristics.

Table 1. Descriptive statistics: corporate governance

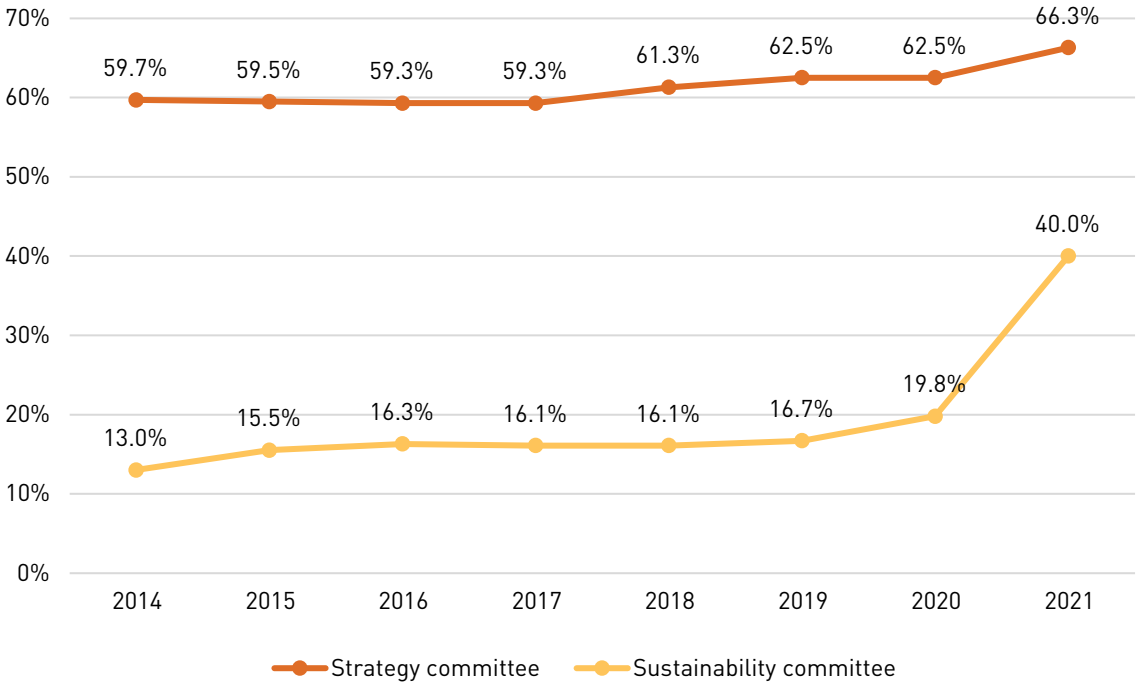
Variable	Obs	Mean	Std. dev.	Min	Max
CEO power					
CEO_Power_{it}	703	0.3043	0.2203	0	0.889
Board committee					
$Audit\_dummy_{it}$	703	0.8919	0.3107	0	1
$Strat\_dummy_{it}$	703	0.6145	0.4870	0	1
$Sust\_dummy_{it}$	703	0.1835	0.3873	0	1
Audit committee characteristics					
$AuditComSize_{it}$	627	3.3716	1.2373	1	5
$AuditComIndep_{it}$	627	0.6104	0.3694	0	1
$AuditComNatDiv_{it}$	627	0.2792	0.3490	0	1
$AuditComTenureDiv_{it}$	627	0.3023	0.2520	0	0.75
$AuditComEduLevDiv_{it}$	627	0.4121	0.2529	0	0.875
$AuditComEduMajorDiv_{it}$	627	0.5030	0.2353	0	0.9
$AuditComFinExp_{it}$	627	0.4795	0.3596	0	1
$AuditComTechExp_{it}$	627	0.2817	0.3073	0	1
$AuditComIndExp_{it}$	627	0.6588	0.3774	0	1
$AuditComCEOExp_{it}$	627	0.4870	0.3636	0	1
$AuditComStateExp_{it}$	627	0.2031	0.2724	0	1
Strategy committee characteristics					
$StratComSize_{it}$	432	4.3680	1.9757	2	6
$StratComIndep_{it}$	432	0.3198	0.2952	0	1
$StratComNatDiv_{it}$	432	0.1860	0.2647	0	1
$StratComTenureDiv_{it}$	432	0.3677	0.2425	0	0.775
$StratComEduLevDiv_{it}$	432	0.4344	0.2470	0	0.83
$StratComEduMajorDiv_{it}$	432	0.5225	0.2352	0	0.94
$StratComFinExp_{it}$	432	0.3722	0.3253	0	1
$StratComTechExp_{it}$	432	0.2876	0.2948	0	1
$StratComIndExp_{it}$	432	0.6917	0.3614	0	1
$StratComCEOExp_{it}$	432	0.5429	0.3449	0	1
$StratComStateExp_{it}$	432	0.2222	0.2980	0	1
Sustainability committee characteristics					
$SustComSize_{it}$	129	3.3256	1.5060	2	4
$SustComIndep_{it}$	129	0.4567	0.3074	0	1
$SustComNatDiv_{it}$	129	0.3198	0.3226	0	1

Variable	Obs	Mean	Std. dev.	Min	Max
$SustComTenureDiv_{it}$	129	0.3383	0.2652	0	0.72
$SustComEduLevDiv_{it}$	129	0.3845	0.2662	0	0.875
$SustComEduMajorDiv_{it}$	129	0.4836	0.2830	0	0.88
$SustComFinExp_{it}$	129	0.3940	0.3866	0	1
$SustComTechExp_{it}$	129	0.3167	0.3151	0	1
$SustComIndExp_{it}$	129	0.7384	0.3340	0	1
$SustComCEOExp_{it}$	129	0.7058	0.2974	0	1
$SustComStateExp_{it}$	129	0.1810	0.2953	0	1

Source: created by the author.

The average board in the sample had 10 members, from 27.8 to 31.8% of whom were independent. However, the average share of women among board members increased from 6.8% in 2014 to 12.5% in 2021. One more considerable change occurred in terms of board committees: while the percentage of boards with audit committees stayed constant (90%) during the whole period of time, the share of boards with strategy and sustainability committees increased (Figure 1).

Figure 1. Share of boards with specialized strategy and sustainability committees



Source: created by the author.

The chart shows that there was a significant shift in 2021 towards the creation of specialized sustainability committees. In previous periods sustainable development issues had frequently been considered by strategy committees [89].

The largest committees in Russian company boards tend to be strategy committees (more than four members on average), while audit and sustainability committees include about three members on average. At the same time, audit committees are the most independent ones (61%), followed by sustainability committees (45.7%). The highest share of foreign directors was in sustainability committees (32%), while the lowest was in strategy committees (18.6%). The average tenure diversity and education diversity in different committees do not differ significantly. As for experience, audit committees accumulate more members with specialized experience in economics & finance (47.9% of committee members on average). The share of members with technical experience does not differ considerably, being at the level of 28-32% (with a higher proportion in sustainability committees). Finally, as expected, the highest share of members with experience in public service is in strategy committees (22.2%).

Table 2 presents the descriptive statistics of company-specific variables, including dependent variables indicating financial performance, and control variables.

Table 2. Descriptive statistics: company financial characteristics

Variable	Obs	Mean	Std. dev.	Min	Max
Financial performance					
$TobinsQ_{it}$	703	0.9789	0.8836	0.1024	10.1802
TSR_{it}	703	0.2655	0.9928	-0.8096	4.0426
Company-specific characteristics					
$Firm\_Size_{it}$	703	12.1823	1.7482	8.0645	17.1131
$FirmAge_{it}$	703	3.3265	0.7403	1.0986	5.5683
$RevGrowth_{it}$	703	0.1867	1.2706	-0.7000	3.8086
$Debt\_Level_{it}$	703	0.3317	0.2293	0.0349	1.6355
$CAPEX\_Level_{it}$	703	0.1219	0.3270	-0.1119	0.9780
ROA_{it}	703	0.0579	0.1249	-1.1642	0.6535
$Oper\_Perf_{it}$	703	0.2559	0.4299	-5.1936	5.1920
$CashHold_{it}$	703	0.1361	1.1822	0	1.3843
$FinSlack_{it}$	703	-0.3427	0.7328	-1.4319	0.8390
$OwnConcentr_{it}$	703	1.4434	1.8891	0.097	9.99
$StateOwn_{it}$	703	0.1863	0.2872	0	1
$Big4_{it}$	703	0.6856	0.4645	0	1

Source: created by the author.

Econometric analysis

At the first stage I conduct panel-data analysis with GLS random-effect (RE) and OLS fixed-effect (FE) regressions, using the White test to check for heteroscedasticity and VIF to identify multicollinearity. In order to make a choice between pooled OLS, RE and FE regressions, I use the Breusch-Pagan, Wooldridge, and Hausman tests.

At the second stage, in order to address issues of endogeneity and heteroscedasticity, I use two-step GMM models with Arellano-Bond dynamic panel-data estimators. For the post-estimation of two-step GMM regressions, I use the Sargan test of overidentifying restrictions and the Arellano-Bond test for first- and second-order autocorrelation in the first-difference errors.

Stage 1. Random-effect and fixed-effect models

To start with, I analyze the impact of board committee characteristics on Tobin's Q, using the specifications of Model 1. Taking into account the sample's limitations, I build three regressions for each committee to evaluate the following effects:

- Committee composition characteristics: size, independence, national diversity, tenure diversity (Model 1a);
- Committee members' education diversity (Model 1b);
- Committee members' professional experience (Model 1c).

The Breusch-Pagan and Hausman tests demonstrate that fixed-effect regressions describe the data better than pooled OLS and GLS random-effect regressions. The results of these regressions are presented in Tables 3–5.

Table 3. Results of fixed-effect OLS regressions for the impact of board committee composition characteristics on Tobin's Q

Committee:	Model 1a_Tobin's Q		
	Sustainability ($SustCom_{it}$)	Strategy ($StratCom_{it}$)	Audit ($AuditCom_{it}$)
ComSize	0.0216 (0.027)	-0.0031 (0.012)	-0.0105 (0.023)
$ComIndep_{it}$	0.0812 (0.143)	0.0578 (0.130)	0.0657 (0.131)
$ComNatDiv_{it}$	-0.1378 (0.145)	-0.1091 (0.193)	-0.1766 (0.155)
$ComTenureDiv_{it}$	0.3431 (0.218)	0.1842 (0.134)	0.0812 (0.120)
ROA_{it}	0.1853 (0.215)	0.2119 (0.233)	0.2371 (0.235)
ROA_{it-1}	0.5032** (0.233)	0.5246** (0.224)	0.5085** (0.250)

Committee:	Model 1a_Tobin's Q		
	Sustainability ($SustCom_{it}$)	Strategy ($StratCom_{it}$)	Audit ($AuditCom_{it}$)
$Firm\_Size_{it}$	-0.4229*** (0.114)	-0.3539*** (0.102)	-0.3869*** (0.112)
$RevGrowth_{it}$	0.0140 (0.074)	0.0166 (0.076)	0.0247 (0.073)
$Debt\_Level_{it}$	0.6370** (0.219)	0.6441** (0.219)	0.6715** (0.225)
$CAPEX\_Level_{it}$	0.0127 (0.015)	0.0053 (0.016)	0.0058 (0.017)
$Oper\_Perf_{it}$	0.0560** (0.026)	0.0665** (0.024)	0.0618** (0.026)
$CashHold_{it}$	-0.7663** (0.367)	-0.6996** (0.349)	-0.7274* (0.369)
$FinSlack_{it}$	0.0458 (0.030)	0.0395 (0.030)	0.0390 (0.030)
$OwnConcentr_{it}$	-0.0052 (0.020)	-0.0073 (0.023)	-0.0118 (0.020)
$StateOwn_{it}$	-0.0575 (0.324)	-0.0119 (0.377)	-0.0667 (0.318)
$Big4_{it}$	0.0235 (0.063)	0.0377 (0.065)	0.0351 (0.065)
CONST	6.0109*** (1.411)	5.0870*** (1.243)	5.6044*** (1.386)
R^2	*0.2326*	*0.2252*	*0.2173*
Robust standard errors	*Yes*	*Yes*	*Yes*
Observations	*574*	*574*	*574*
Regression type	*OLS FE*	*OLS FE*	*OLS FE*
Hausman test p-value	*0.0000*	*0.0000*	*0.0000*

Note: standard errors in parenthesis; statistical significance: *p<0.1 **p<0.05 ***p<0.01.
Source: created by the author.

Table 4. Results of fixed-effect OLS regressions for the impact of the education diversity of board committee members on Tobin's Q

Committee:	Model 1b_Tobin's Q		
	$SustCom_{it}$	$StratCom_{it}$	$AuditCom_{it}$
$ComEduLevDiv_{it}$	0.1405 (0.221)	0.3108** (0.116)	-0.0043 (0.150)
$ComEduLevDiv_{it-1}$	0.3329** (0.138)	0.1170 (0.123)	0.1225 (0.121)
$ComEduMajorDiv_{it}$	0.1687 (0.166)	-0.1073 (0.098)	0.1188 (0.163)
$ComEduMajorDiv_{it-1}$	-0.0727 (0.221)	-0.2916** (0.121)	-0.0187 (0.129)
ROA_{it}	0.1714 (0.219)	0.1461 (0.219)	0.2152 (0.223)
ROA_{it-1}	0.4736** (0.236)	0.5261** (0.222)	0.5133** (0.250)
$Firm\_Size_{it}$	-0.4001*** (0.112)	-0.3533*** (0.098)	-0.3617*** (0.102)
$RevGrowth_{it}$	0.0109 (0.072)	0.0069 (0.071)	0.0190 (0.074)
$Debt\_Level_{it}$	0.6154** (0.215)	0.5654** (0.223)	0.6413** (0.223)
$CAPEX\_Level_{it}$	0.0097 (0.015)	0.0114 (0.014)	0.0059 (0.015)
$Oper\_Perf_{it}$	0.0554** (0.025)	0.0631** (0.022)	0.0620** (0.024)
$CashHold_{it}$	-0.7588** (0.366)	-0.6805* (0.361)	-0.6841* (0.368)
$FinSlack_{it}$	0.0445 (0.030)	0.0506 (0.032)	0.0474 (0.033)
$OwnConcentr_{it}$	-0.0027 (0.021)	-0.0102 (0.023)	-0.0070 (0.021)
$StateOwn_{it}$	-0.0574 (0.320)	-0.2135 (0.304)	-0.1142 (0.343)
$Big4_{it}$	0.0254 (0.063)	0.0397 (0.067)	0.0304 (0.067)

Committee:	Model 1b_Tobin's Q		
	$SustCom_{it}$	$StratCom_{it}$	$AuditCom_{it}$
CONST	5.7320*** (1.395)	5.2403*** (1.224)	5.2035*** (1.282)
R^2	*0.2288*	*0.2385*	*0.2159*
Robust standard errors	*Yes*	*Yes*	*Yes*
Observations	*574*	*574*	*574*
Regression type	*OLS FE*	*OLS FE*	*OLS FE*
Hausman test p-value	*0.0000*	*0.0000*	*0.0000*

Note: standard errors in parenthesis; statistical significance: *p<0.1 **p<0.05 ***p<0.01.

Source: created by the author.

Table 5. Results of fixed-effect OLS regressions for the impact of the professional experience diversity of board committee members on Tobin's Q

Committee:	Model 1c_Tobin's Q		
	$SustCom_{it}$	$StratCom_{it}$	$AuditCom_{it}$
$ComFinExp_{it}$	0.2493** (0.115)	0.1126 (0.098)	0.0656 (0.128)
$ComFinExp_{it-1}$	0.5316*** (0.169)	0.1397 (0.096)	-0.1496* (0.077)
$ComTechExp_{it}$	0.0095 (0.188)	0.1670* (0.092)	-0.0546 (0.119)
$ComTechExp_{it-1}$	0.1186 (0.164)	-0.0904 (0.104)	-0.0368 (0.099)
$ComIndExp_{it}$	0.1509 (0.011)	-0.1951* (0.100)	-0.0851 (0.084)
$ComIndExp_{it-1}$	-0.1810* (0.096)	0.0493 (0.077)	-0.1194 (0.098)
$ComCEOExp_{it}$	-0.0981 (0.120)	-0.0058 (0.078)	0.0650 (0.094)
$ComCEOExp_{it-1}$	0.0132 (0.110)	-0.0273 (0.093)	-0.0333 (0.083)
$ComStateExp_{it}$	-0.2562 (0.171)	0.1446 (0.122)	0.2141** (0.106)
$ComStateExp_{it-1}$	0.3015** (0.119)	-0.1297 (0.117)	0.2295** (0.108)
ROA_{it}	0.2342 (0.214)	0.1923 (0.216)	0.1890 (0.229)
ROA_{it-1}	0.5891** (0.248)	0.5391** (0.236)	0.5406** (0.237)
$Firm\_Size_{it}$	-0.4123*** (0.113)	-0.3953*** (0.108)	-0.3819*** (0.107)
$RevGrowth_{it}$	0.0029 (0.072)	0.0238 (0.068)	0.0208 (0.067)
$Debt\_Level_{it}$	0.6198** (0.226)	0.5989** (0.215)	0.5461** (0.211)
$CAPEX\_Level_{it}$	0.0069 (0.015)	0.0090 (0.015)	0.0140 (0.019)
$Oper\_Perf_{it}$	0.0639** (0.027)	0.0621** (0.024)	0.0546* (0.031)
$CashHold_{it}$	-0.7251* (0.376)	-0.6789* (0.394)	-0.7300* (0.389)
$FinSlack_{it}$	0.0456 (0.031)	0.0450 (0.034)	0.0371 (0.034)
$OwnConcentr_{it}$	0.0126 (0.018)	-0.0098 (0.021)	-0.0176 (0.019)
$StateOwn_{it}$	-0.1698 (0.328)	0.0473 (0.355)	-0.1152 (0.264)
$Big4_{it}$	0.0293 (0.065)	0.0541 (0.061)	0.0748 (0.062)
CONST	5.8583*** (1.395)	5.6754*** (1.341)	5.6450*** (1.332)
R^2	*0.2575*	*0.2332*	*0.2432*
Robust standard errors	*Yes*	*Yes*	*Yes*
Observations	*574*	*574*	*574*
Regression type	*OLS FE*	*OLS FE*	*OLS FE*
Hausman test p-value	*0.0000*	*0.0000*	*0.0000*

Note: standard errors in parenthesis; statistical significance: *p<0.1 **p<0.05 ***p<0.01.

Source: created by the author.

The explanatory power of the regressions presented in Tables 3–5 is relatively low, varying from 0.2159 to 0.2575. Nevertheless, these regressions are significant at all levels. According to the obtained results, board committee size, independence, national diversity and tenure diversity have statistically insignificant coefficients in relation with Tobin's Q. According to the results presented in Table 4, a more diversified educational attainment of the sustainability committee (with a 1-year lag) and the strategy committee (without a 1-year lag) contributes to higher Tobin's Q at the 5% significance level. At the same time, a strategy committee with more diversified educational majors (with a 1-year lag) decrease corporate Tobin's Q, with the coefficient being significant at the 5% level.

I also found that the professional background of board committee members significantly affects Tobin's Q; additionally, regressions including this variable for sustainability and audit committee have higher explanatory power compared to regressions including composition and education variables. According to the results presented in Table 5, a higher share of sustainability committee members with professional experience has a significant positive impact on Tobin's Q, and this effect is stronger with a 1-year lag (the coefficients 0.2493 and 0.5316 are significant at the 5% and 1% levels, respectively). On the other hand, the results demonstrate that a higher proportion of audit committee members with financial expertise may negatively affect Tobin's Q with a 1-year lag; however, this effect is weaker (-0.1496 at the 10% level). I also found that a higher share of sustainability and strategy committee members with industry-specific experience leads to a decrease in Tobin's Q (these effects are significant at the 10% level). Interestingly, a higher proportion of directors with public service work experience in sustainability and audit committees significantly contributes to Tobin's Q (coefficients are significant at the 5% level); for audit committees, this effect is stronger.

Further, using the specifications of Models 1a, 1b and 1c, I analyze the impact of board committee characteristics on Total Shareholder Return (TSR). Interestingly, despite the limited sample, the Breusch-Pagan and Hausman tests for these models demonstrate that GLS random-effect regressions describe the data better than pooled OLS and OLS fixed-effect regressions. The results of these regressions are presented in Tables 6–8.

Table 6. Results of random-effect GLS regressions for the impact of board committee composition characteristics on TSR

Committee:	Model 1a_TSR		
	$SustCom_{it}$	$StratCom_{it}$	$AuditCom_{it}$
$ComSize_{it}$	-0.0242 (0.059)	-0.0308 (0.023)	0.0417 (0.033)
$ComIndep_{it}$	0.1332 (0.312)	0.3183** (0.130)	-0.0228 (0.132)
$ComNatDiv_{it}$	-0.0212 (0.288)	0.0248 (0.176)	0.1780 (0.147)
$ComTenureDiv_{it}$	0.3169 (0.284)	-0.0245 (0.113)	0.1484 (0.154)
ROA_{it}	1.0841** (0.513)	1.1410** (0.518)	1.0645** (0.503)
ROA_{it-1}	-0.3508 (0.529)	-0.3131 (0.557)	-0.3579 (0.555)
$Firm\_Size_{it}$	-0.0174 (0.024)	-0.0096 (0.025)	-0.0214 (0.027)
$RevGrowth_{it}$	0.2425** (0.103)	0.2506** (0.101)	0.2386** (0.103)
$Debt\_Level_{it}$	0.3295 (0.258)	0.3814 (0.273)	0.2922 (0.247)
$CAPEX\_Level_{it}$	-0.0123 (0.023)	-0.0501* (0.027)	-0.0071 (0.025)
$Oper\_Perf_{it}$	-0.0543 (0.052)	-0.0448 (0.055)	-0.0564 (0.052)
$CashHold_{it}$	0.0371 (0.205)	0.0434 (0.201)	0.0945 (0.214)
$FinSlack_{it}$	0.0287 (0.042)	0.0245 (0.041)	0.0390 (0.041)
$OwnConcentr_{it}$	-0.0362 (0.024)	-0.0397 (0.025)	-0.0254 (0.021)
$StateOwn_{it}$	-0.0959 (0.173)	-0.0651 (0.128)	-0.1396 (0.172)
$Big4_{it}$	-0.0640 (0.092)	-0.0585 (0.085)	-0.0854 (0.086)
CONST	0.4406 (0.304)	0.3611 (0.312)	0.3285 (0.310)
R^2	*0.0552*	*0.0582*	*0.0561*
Robust standard errors	*Yes*	*Yes*	*Yes*
Observations	*574*	*574*	*574*
Regression type	*GLS RE*	*GLS RE*	*GLS RE*
Hausman test p-value	*0.8624*	*0.9898*	*0.8823*

Note: standard errors in parenthesis; statistical significance: *p<0.1 **p<0.05 ***p<0.01.

Source: created by the author.

Table 7. Results of random-effect GLS regressions for the impact of the education diversity of board committee members on TSR

Committee:	Model 1b_TSR		
	$SustCom_{it}$	$StratCom_{it}$	$AuditCom_{it}$
$ComEduLevDiv_{it}$	-0.0448 (0.309)	0.0507 (0.144)	0.0998 (0.169)
$ComEduLevDiv_{it-1}$	0.3295 (0.395)	-	0.0337 (0.198)
$ComEduMajorDiv_{it}$	0.1013 (0.248)	-0.1160 (0.139)	-0.0790 (0.168)
$ComEduMajorDiv_{it-1}$	-0.4139 (0.326)	-	-0.0869 (0.170)
ROA_{it}	1.1056** (0.520)	1.1199** (0.504)	1.1108** (0.509)
ROA_{it-1}	-0.3376 (0.560)	-0.3382 (0.542)	-0.3394 (0.542)
$Firm\_Size_{it}$	-0.0064 (0.024)	-0.0076 (0.027)	-0.0108 (0.029)
$RevGrowth_{it}$	0.2394** (0.102)	0.2458** (0.102)	0.2440** (0.102)
$Debt\_Level_{it}$	0.3396 (0.267)	0.3510 (0.264)	0.3560 (0.269)
$CAPEX\_Level_{it}$	-0.0161 (0.021)	-0.0195 (0.022)	-0.0161 (0.021)
$Oper\_Perf_{it}$	-0.0512 (0.053)	-0.0501 (0.052)	-0.0536 (0.053)
$CashHold_{it}$	0.0807 (0.206)	0.0764 (0.208)	0.1006 (0.211)
$FinSlack_{it}$	0.0266 (0.041)	0.0267 (0.042)	0.0298 (0.042)
$OwnConcentr_{it}$	-0.0357 (0.025)	-0.0376 (0.024)	-0.0366 (0.023)
$StateOwn_{it}$	-0.1406 (0.175)	-0.1371 (0.166)	-0.1290 (0.174)
$Big4_{it}$	-0.0545 (0.092)	-0.0572 (0.088)	-0.0634 (0.087)
CONST	0.3168 (0.302)	0.3611 (0.312)	0.3898 (0.325)
R^2	*0.0520*	*0.0531*	*0.0533*
Robust standard errors	*Yes*	*Yes*	*Yes*
Observations	*574*	*574*	*574*
Regression type	*GLS RE*	*GLS RE*	*GLS RE*
Hausman test p-value	*0.9381*	*0.9530*	*0.9820*

Note: standard errors in parenthesis; statistical significance: *p<0.1 **p<0.05 ***p<0.01.

Source: created by the author.

Table 8. Results of random-effect GLS regressions for the impact of the professional experience diversity of board committee members on TSR

Committee:	Model 1c_TSR		
	$SustCom_{it}$	$StratCom_{it}$	$AuditCom_{it}$
$ComFinExp_{it}$	0.1272 (0.174)	0.1177 (0.170)	0.3682*** (0.118)
$ComFinExp_{it-1}$	0.8869* (0.481)	-0.0946 (0.219)	-0.1509 (0.176)
$ComTechExp_{it}$	0.3192 (0.265)	0.2393 (0.212)	0.1063 (0.182)
$ComTechExp_{it-1}$	0.2254 (0.355)	0.0641 (0.252)	-0.2610* (0.146)
$ComIndExp_{it}$	-0.1516 (0.201)	-0.1357 (0.131)	-0.1336 (0.094)
$ComIndExp_{it-1}$	-0.3284 (0.229)	-0.0944 (0.120)	0.1565 (0.099)
$ComCEOExp_{it}$	-0.1466 (0.175)	0.1558 (0.136)	0.0224 (0.104)
$ComCEOExp_{it-1}$	-0.0639 (0.207)	-0.0669 (0.177)	0.0964 (0.144)
$ComStateExp_{it}$	0.1557 (0.276)	-0.0755 (0.246)	-0.1019 (0.146)
$ComStateExp_{it-1}$	0.0922 (0.201)	-0.1852 (0.205)	0.2580 (0.179)
ROA_{it}	1.1126** (0.524)	1.0424** (0.518)	1.0581** (0.505)
ROA_{it}	-0.2751 (0.520)	-0.3479 (0.551)	-0.3457 (0.537)
$Firm\_Size_{it}$	-0.0167 (0.023)	-0.0074 (0.025)	-0.0221 (0.027)
$RevGrowth_{it}$	0.2270** (0.099)	0.2419** (0.099)	0.2688** (0.097)
$Debt\_Level_{it}$	0.3018 (0.247)	0.3083 (0.254)	0.3380 (0.275)

Committee:	Model 1c_TSR		
	$SustCom_{it}$	$StratCom_{it}$	$AuditCom_{it}$
$CAPEX\_Level_{it}$	-0.0264 (0.020)	-0.0003 (0.023)	-0.0134 (0.018)
$Oper\_Perf_{it}$	-0.0485 (0.054)	-0.0546 (0.052)	-0.0495 (0.052)
$CashHold_{it}$	0.0598 (0.209)	0.0779 (0.201)	0.0457 (0.195)
$FinSlack_{it}$	0.0279 (0.042)	0.0319 (0.040)	0.0230 (0.041)
$OwnConcentr_{it}$	-0.0235 (0.025)	-0.0432 (0.026)	-0.0282 (0.020)
$StateOwn_{it}$	-0.1235 (0.188)	-0.0888 (0.160)	-0.1252 (0.150)
$Big4_{it}$	-0.0701 (0.088)	-0.0330 (0.078)	-0.0613 (0.085)
CONST	0.4282 (0.300)	0.3660 (0.344)	0.3564 (0.298)
R^2	*0.0890*	*0.0626*	*0.0699*
Robust standard errors	*Yes*	*Yes*	*Yes*
Observations	*574*	*574*	*574*
Regression type	*GLS RE*	*GLS RE*	*GLS RE*
Hausman test p-value	*0.7741*	*0.9972*	*0.9774*

Note: standard errors in parenthesis; statistical significance: *p<0.1 **p<0.05 ***p<0.01.

Source: created by the author.

The explanatory power of regressions presented in Tables 6-8 is low. Nevertheless, these regressions are significant at all levels. According to the obtained results, the education diversity of board committee members does not have a significant impact on TSR. The higher independence of the strategy committee has a significant positive impact on TSR (the coefficient 0.3183 is significant at the 5% level).

TSR is also affected by the professional experience of board committee members. According to the results presented in Table 8, a higher proportion of sustainability committee members (with a 1-year lag) and audit committee members (without a 1-year lag) with professional experience in finance significantly improves TSR, and this effect is stronger for sustainability committee members. However, a higher proportion of audit committee members with experience in technical fields negatively affects TSR, which is an unexpected result. Other types of professional experience of board committee members do not affect TSR significantly.

There are several limitations of the usage of random-effect and fixed-effect models. Firstly, in some regressions I had to drop certain variables due to multicollinearity issues. Secondly, I found some heteroscedasticity issues for regressions with Tobin's Q as a dependent variable. Thirdly, although I have not found any endogeneity of board committee characteristics due to company characteristics (size, age, etc.), corporate governance may be affected by its characteristics in previous periods [90–91]. Additionally, corporate financial performance also may be affected by its performance in previous periods. Taking into account these circumstances, at the second stage of my econometric analysis I use a two-step generalized method of moments (GMM). According to Wintoki et al. [91], two-step GMM is one of the most widely used approaches to address the problem of endogeneity in models considering corporate governance, as it measures the endogeneity of explanatory variables. In my research, I use Arellano-Bond dynamic panel data estimation with a one-year lag in the dependent variable and a one- or two-year lag in the independent variables to track the effects of previous periods for these variables. This estimation can also be used to identify heteroscedasticity issues.

Stage 2. Two-step GMM models

As in Stage 1, I build regressions to evaluate the following effects:

- Committee composition characteristics: size, independence, national diversity, tenure diversity (Model 1a);
- Committee members' education diversity (Model 1b);
- Committee members' professional experience (Model 1c).

Additionally, I build regressions taking into account the moderating effect of the CEO power index on the following:

- Committee composition characteristics multiplied by (1 – CEO power index): size, independence, national diversity, tenure diversity (Model 2a);
- Committee members' education diversity multiplied by (1 – CEO power index) (Model 2b);
- Committee members' professional experience multiplied by (1 – CEO power index) (Model 2c).

Table 9 presents the results of Model 1a and Model 2a regressions, reflecting the impact of board committee composition on Tobin's Q. Table 10 shows the results of Model 1b and Model 2b regressions, reflecting the impact of the education diversity of board committee members on Tobin's Q. Finally, Table 11 presents the results of Model 1c and Model 2c regressions, reflecting the impact of board committee members' professional experience diversity on Tobin's Q.

Table 9. Two-step GMM Arellano-Bond dynamic panel data estimations for the impact of board committee composition characteristics on Tobin's Q

	$SustCom_{it}$	$SustCom_{it}\times(1 - CEO\_Power_{it})$	$StratCom_{it}$	$StratCom_{it}\times(1 - CEO\_Power_{it})$	$AuditCom_{it}$	$AuditCom_{it}\times(1 - CEO\_Power_{it})$
$TobinsQ_{it-1}$	0.1979** (0.0643)	0.1979** (0.0643)	0.1970** (0.066)	0.1978** (0.071)	0.2039*** (0.058)	0.1995** (0.067)
$ComSize_{it}$	-0.0172 (0.021)	-0.0231 (0.025)	-0.0121 (0.011)	-0.0066 (0.011)	0.0080 (0.020)	0.0166 (0.019)
$ComSize_{it-1}$	0.0143 (0.052)	0.0107 (0.056)	0.0012 (0.013)	-0.0071 (0.013)	-0.0092 (0.025)	-0.0075 (0.027)
$ComIndep_{it}$	0.0109 (0.131)	0.0358 (0.143)	-0.0199 (0.101)	-0.0579 (0.141)	-0.0466 (0.076)	-0.1080 (0.112)
$ComIndep_{it-1}$	0.0088 (0.180)	-0.0113 (0.190)	-0.0845 (0.072)	-0.0753 (0.106)	-0.0230 (0.056)	-0.0550 (0.075)
$ComNatDiv_{it}$	-0.0497 (0.166)	-0.0014 (0.154)	-0.0807 (0.138)	-0.0226 (0.165)	0.0157 (0.097)	0.1252 (0.146)
$ComNatDiv_{it-1}$	-0.1178 (0.166)	-0.0971 (0.228)	-0.0152 (0.097)	-0.0161 (0.154)	-0.0724 (0.082)	-0.0427 (0.117)
$ComTenureDiv_{it}$	0.2591 (0.180)	0.2748* (0.159)	-0.0236 (0.095)	-0.0079 (0.096)	-0.0418 (0.071)	-0.0597 (0.118)
$ComTenureDiv_{it-1}$	0.1036 (0.163)	0.1573 (0.152)	-0.0370 (0.081)	-0.0131 (0.091)	0.0667 (0.077)	0.0573 (0.118)
ROA_{it}	-0.0104 (0.174)	-0.0111 (0.169)	-0.0192 (0.177)	-0.0259 (0.173)	-0.0309 (0.161)	-0.0301 (0.170)
ROA_{it-1}	0.2055 (0.241)	0.2140 (0.236)	0.2424 (0.278)	0.2804 (0.254)	0.1558 (0.237)	0.1978 (0.223)
$Firm\_Size_{it}$	-0.5938*** (0.144)	-0.6001*** (0.141)	-0.5699*** (0.155)	-0.5729*** (0.156)	-0.5305*** (0.140)	-0.5612*** (0.141)
$FirmAge_{it}$	0.8722** (0.415)	0.9455** (0.402)	0.9550** (0.435)	1.0007** (0.433)	0.8399** (0.416)	0.9743** (0.402)
$RevGrowth_{it}$	0.1518* (0.091)	0.1590* (0.086)	0.1820* (0.095)	0.1855* (0.097)	0.1418* (0.083)	0.1491* (0.087)
$Debt\_Level_{it}$	0.6105** (0.246)	0.6163** (0.235)	0.5667** (0.233)	0.5978** (0.223)	0.5413** (0.224)	0.5747** (0.227)
$CAPEX\_Level_{it}$	0.0164 (0.026)	0.0156 (0.026)	0.0136 (0.030)	0.0131 (0.027)	0.0163 (0.032)	0.0174 (0.026)
$Oper\_Perf_{it}$	0.0343* (0.018)	0.0341* (0.017)	0.0352* (0.020)	0.0372** (0.018)	0.0311** (0.015)	0.0319** (0.015)
$CashHold_{it}$	-0.0538 (0.184)	-0.0721 (0.181)	-0.0499 (0.169)	-0.0537 (0.169)	-0.0628 (0.180)	-0.0389 (0.175)
$FinSlack_{it}$	0.0089 (0.043)	0.0058 (0.041)	0.0040 (0.045)	0.0032 (0.047)	0.0172 (0.040)	0.0133 (0.042)
$OwnConcentr_{it}$	0.0148 (0.021)	0.0205 (0.020)	0.0147 (0.018)	0.0221 (0.020)	0.0263 (0.018)	0.0308 (0.020)
$StateOwn_{it}$	-1.2640** (0.534)	-1.2473** (0.512)	-1.2403** (0.581)	-1.2490** (0.587)	-1.1603** (0.450)	-1.1377** (0.471)
$Big4_{it}$	0.0151 (0.060)	0.0216 (0.059)	0.0360 (0.063)	0.0218 (0.064)	0.0011 (0.062)	0.0135 (0.062)
CONST	5.1165*** (1.263)	4.9419*** (1.256)	4.6298*** (1.348)	4.4597*** (1.338)	4.4937** (1.392)	4.3719** (1.385)
Sargan test (p-value)	*21.7589 (0.3537)*	*19.7307 (0.4749)*	*21.4126 (0.3732)*	*20.2833 (0.4403)*	*20.7151 (0.4141)*	*19.2656 (0.5046)*
AR(2) (p-value)	*-1.5769 (0.1148)*	*-1.5435 (0.1227)*	*-1.6209 (0.1150)*	*-1.5977 (0.1101)*	*-1.6091 (0.1176)*	*-1.5937 (0.1110)*
Robust SE	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Observations	*486*	*486*	*486*	*486*	*486*	*486*

Note: standard errors in parenthesis; statistical significance: *p<0.1 **p<0.05 ***p<0.01.

Source: created by the author.

Table 10. Two-step GMM Arellano-Bond dynamic panel data estimations for the impact of the education diversity of board committee members on Tobin's Q

	$SustCom_{it}$	$SustCom_{it}\times(1 - CEO\_Power_{it})$	$StratCom_{it}$	$StratCom_{it}\times(1 - CEO\_Power_{it})$	$AuditCom_{it}$	$AuditCom_{it}\times(1 - CEO\_Power_{it})$
$TobinsQ_{it-1}$	0.1974** (0.062)	0.1939** (0.063)	0.1938** (0.067)	0.1925** (0.067)	0.2033** (0.063)	0.1934** (0.065)
$ComEduLevDiv_{it}$	0.0227 (0.180)	0.1101 (0.228)	0.0557 (0.095)	0.0136 (0.120)	-0.0056 (0.074)	-0.0709 (0.099)
$ComEduLevDiv_{it-1}$	0.2393** (0.111)	0.4083** (0.124)	-0.0054 (0.081)	-0.0026 (0.099)	0.0553 (0.075)	0.0005 (0.101)
$ComEduMajorDiv_{it}$	0.0582 (0.165)	-0.0199 (0.167)	-0.0461 (0.075)	-0.0294 (0.077)	0.0086 (0.078)	0.0492 (0.093)
$ComEduMajorDiv_{it-1}$	-0.1182 (0.336)	-0.4186 (0.374)	-0.1195 (0.083)	-0.1311 (0.093)	-0.0270 (0.098)	-0.1031 (0.125)
ROA_{it}	-0.0168 (0.165)	-0.0092 (0.162)	-0.0249 (0.166)	0.0006 (0.167)	-0.0448 (0.169)	-0.0256 (0.172)
ROA_{it-1}	0.2255 (0.232)	0.2258 (0.236)	0.2572 (0.264)	0.2870 (0.244)	0.1722 (0.241)	0.1978 (0.243)
$Firm\_Size_{it}$	-0.5966*** (0.146)	-0.5673*** (0.147)	-0.5382*** (0.143)	-0.5557*** (0.139)	-0.5182*** (0.141)	-0.5474*** (0.140)
$FirmAge_{it}$	0.9349** (0.403)	0.9244** (0.411)	0.7870* (0.422)	0.8876** (0.395)	0.8560** (0.413)	0.9274** (0.386)
$RevGrowth_{it}$	0.1624* (0.072)	0.1470* (0.085)	0.1667* (0.088)	0.1669* (0.086)	0.1341* (0.082)	0.1338* (0.081)
$Debt\_Level_{it}$	0.6080** (0.227)	0.6048** (0.225)	0.6172** (0.233)	0.6178** (0.224)	0.6271** (0.231)	0.6401** (0.221)
$CAPEX\_Level_{it}$	0.0169 (0.027)	0.0164 (0.028)	0.0157 (0.026)	0.0147 (0.025)	0.0148 (0.031)	0.0168 (0.027)
$Oper\_Perf_{it}$	0.0328* (0.017)	0.0335* (0.017)	0.0345* (0.018)	0.0357** (0.017)	0.0313* (0.017)	0.0302* (0.016)
$CashHold_{it}$	-0.0342 (0.166)	-0.0530 (0.165)	-0.0664 (0.171)	-0.0519 (0.170)	-0.0731 (0.041)	-0.0768 (0.188)
$FinSlack_{it}$	0.0056 (0.043)	0.0108 (0.042)	0.0051 (0.041)	0.0027 (0.041)	0.0252 (0.041)	0.0203 (0.042)
$OwnConcentr_{it}$	0.0219 (0.018)	0.0206 (0.017)	0.0163 (0.018)	0.0245 (0.019)	0.0206 (0.021)	0.0264 (0.021)
$StateOwn_{it}$	-1.1772** (0.504)	-1.1502** (0.506)	-1.2890** (0.497)	-1.2637** (0.500)	-1.1365** (0.538)	-1.1575** (0.503)
$Big4_{it}$	0.0205 (0.058)	0.0189 (0.058)	0.0130 (0.061)	0.0039 (0.064)	-0.0035 (0.059)	-0.0043 (0.060)
CONST	4.8947*** (1.350)	4.5892** (1.352)	4.7862*** (1.299)	4.6221*** (1.327)	4.2441*** (1.279)	4.3949** (1.299)
Sargan test (p-value)	*19.7558 (0.4733)*	*20.2210 (0.4442)*	*20.9744 (0.3986)*	*20.2322 (0.4435)*	*19.9600 (0.4604)*	*19.2063 (0.5085)*
AR(2) (p-value)	*-1.5186 (0.1289)*	*-1.5567 (0.1195)*	*-1.5986 (0.1199)*	*-1.6063 (0.1182)*	*-1.6245 (0.1143)*	*-1.5434 (0.1227)*
Robust SE	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Observations	*486*	*486*	*486*	*486*	*486*	*486*

Note: standard errors in parenthesis; statistical significance: *p<0.1 **p<0.05 ***p<0.01.

Source: created by the author.

Table 11. Two-step GMM Arellano-Bond dynamic panel data estimations for the impact of board committee members' experience on Tobin's Q

	$SustCom_{it}$	$SustCom_{it}$×(1 – CEO_Power_{it})	$StratCom_{it}$	$StratCom_{it}$×(1 – CEO_Power_{it})	$AuditCom_{it}$	$AuditCom_{it}$×(1 – CEO_Power_{it})
$TobinsQ_{it-1}$	0.2212** (0.064)	0.2063** (0.064)	0.1945** (0.063)	0.1962** (0.065)	0.1830** (0.075)	0.1817** (0.076)
$ComFinExp_{it}$	0.0412 (0.080)	0.0995 (0.075)	0.0086 (0.070)	0.0261 (0.091)	0.0770 (0.090)	0.1056 (0.126)
$ComFinExp_{it-1}$	0.3155 (0.229)	0.5877* (0.327)	0.1247 (0.118)	0.0888 (0.122)	-0.0003 (0.100)	-0.0010 (0.106)
$ComTechExp_{it}$	0.1154 (0.133)	0.1248 (0.156)	0.1253* (0.073)	0.1333 (0.104)	-0.0495 (0.086)	-0.1090 (0.127)
$ComTechExp_{it-1}$	0.2484 (0.170)	0.2700 (0.200)	-0.1981* (0.108)	-0.2147 (0.133)	-0.1125 (0.084)	-0.2280 (0.154)
$ComIndExp_{it}$	0.0819 (0.124)	0.1171 (0.173)	-0.0311 (0.073)	0.0096 (0.085)	-0.0068 (0.076)	-0.0075 (0.083)
$ComIndExp_{it-1}$	-0.2897** (0.113)	-0.4289** (0.186)	-0.2155 (0.077)	-0.1209 (0.096)	-0.0330 (0.063)	-0.0865 (0.105)
$ComCEOExp_{it}$	-0.1564 (0.120)	-0.2503* (0.144)	-0.0770 (0.072)	-0.1028 (0.108)	-0.0333 (0.069)	-0.0296 (0.087)
$ComCEOExp_{it-1}$	0.0579 (0.130)	0.1289 (0.236)	0.1272 (0.109)	0.1487 (0.131)	0.0261 (0.074)	0.0344 (0.118)
$ComStateExp_{it}$	-0.0782 (0.217)	-0.0195 (0.199)	-0.0048 (0.114)	0.0225 (0.165)	0.1204* (0.072)	0.1302 (0.134)
$ComStateExp_{it-1}$	0.3478* (0.180)	0.5447** (0.231)	0.1210 (0.087)	0.2015 (0.150)	0.1440 (0.108)	0.2713* (0.157)
ROA_{it}	-0.0744 (0.150)	-0.0522 (0.147)	0.0382 (0.172)	0.0320 (0.173)	0.0207 (0.150)	0.0239 (0.152)
ROA_{it-1}	0.1607 (0.200)	0.2154 (0.199)	0.2947 (0.221)	0.2693 (0.217)	0.3399 (0.266)	0.3696 (0.261)
$Firm\_Size_{it}$	-0.5107** (0.159)	-0.5397*** (0.157)	-0.5907*** (0.143)	-0.5564*** (0.145)	-0.5560*** (0.163)	-0.5516*** (0.169)
$FirmAge_{it}$	0.8908** (0.428)	0.9307** (0.424)	0.8499** (0.387)	0.7934** (0.399)	1.0001** (0.456)	1.0099** (0.462)
$RevGrowth_{it}$	0.1440* (0.086)	0.1422* (0.082)	0.1911* (0.114)	0.1740* (0.106)	0.1596* (0.083)	0.1576* (0.081)
$Debt\_Level_{it}$	0.6920*** (0.196)	0.6997*** (0.184)	0.6696** (0.227)	0.6588** (0.224)	0.6974** (0.234)	0.7269** (0.235)
$CAPEX\_Level_{it}$	0.0207 (0.027)	0.0185 (0.026)	0.0116 (0.026)	0.0159 (0.024)	0.0149 (0.019)	0.0182 (0.017)
$Oper\_Perf_{it}$	0.0277* (0.016)	0.0307** (0.015)	0.0422** (0.020)	0.0357** (0.018)	0.0367** (0.017)	0.0333** (0.017)
$CashHold_{it}$	-0.0611 (0.165)	-0.0648 (0.161)	-0.0484 (0.164)	-0.0916 (0.170)	-0.1451 (0.186)	-0.1723 (0.187)
$FinSlack_{it}$	0.0262 (0.038)	0.0196 (0.039)	-0.0085 (0.048)	0.0061 (0.047)	0.0001 (0.042)	0.0037 (0.038)
$OwnConcentr_{it}$	0.0153 (0.020)	0.0135 (0.018)	0.0150 (0.017)	0.0171 (0.018)	0.0185 (0.019)	0.0160 (0.023)
$StateOwn_{it}$	-1.2139** (0.501)	-1.1372** (0.499)	-1.0761** (0.516)	-1.1053** (0.513)	-0.8884** (0.424)	-0.7806** (0.350)
$Big4_{it}$	0.0124 (0.059)	0.0090 (0.056)	0.0241 (0.060)	0.0154 (0.061)	-0.0034 (0.059)	0.0026 (0.064)
CONST	3.9790** (1.378)	4.1890** (1.372)	5.0608*** (1.399)	4.8724** (1.409)	4.1749*** (1.210)	4.1215** (1.309)
Sargan test (p-value)	*22.1181 (0.3341)*	*20.5916 (0.4215)*	*20.6543 (0.4177)*	*20.4637 (0.4293)*	*20.7725 (0.4106)*	*24.8173 (0.2085)*
AR(2) (p-value)	*-1.5771 (0.1148)*	*-1.5604 (0.1187)*	*-1.5676 (0.1170)*	*-1.5774 (0.1147)*	*-1.5793 (0.1143)*	*-1.5995 (0.1107)*
Robust SE	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Observations	*486*	*486*	*486*	*486*	*486*	*486*

Note: standard errors in parenthesis; statistical significance: *p<0.1 **p<0.05 ***p<0.01.

Source: created by the author.

The results show that there is no statistically significant impact of board committee size, independence and national diversity on Tobin's Q, which is in line with the results obtained using OLS fixed-effect estimations. As for tenure diversity, only for the sustainability committee does it have a slightly significant positive impact on Tobin's Q, moderated by CEO power. The coefficient of the variable allowing for the deterring role of CEO power is significant at the 10% level, which proves that CEO power mitigates the positive effect of sustainability committee tenure diversity.

Turning to Table 10, we see that there is a statistically significant (at the 5% level) positive impact of sustainability committee diversity in terms of its members' education attainment on Tobin's Q. This effect is even greater taking into account the deterring effect of CEO power. At the same time, there is no significant impact of committee educational major diversity on Tobin's Q.

According to the results presented in Table 11, some characteristics of board committee members' experience affect Tobin's Q. Firstly, the experience of sustainability committee members in finance slightly contributes to corporate performance measured by Tobin's Q; however, this effect is significant only in the case of lower CEO power (the coefficient 0.5877 is significant at the 10% level). Secondly, there are negative effects of sustainability committee members' industry-specific experience (significant at the 5% level) and experience of being a CEO or its equivalent in the public or academic field (significant at the 10% level), which may be mitigated by a more powerful CEO. Finally, a higher proportion of members with experience in public service on the sustainability and audit committees enhances Tobin's Q, and this effect is significantly stronger for sustainability committee members.

The results of building two-step GMM models for TSR are presented in Tables 12 and 13.

Table 12. Two-step GMM Arellano-Bond dynamic panel data estimations for the impact of board committee composition characteristics on TSR

	$StratCom_{it}$	$StratCom_{it} \times (1 - CEO\_Power_{it})$
TSR_{it-1}	0.1543** (0.075)	0.1542** (0.077)
$ComSize_{it}$	-0.0106 (0.032)	0.0163 (0.033)
$ComSize_{it-1}$	-0.0472 (0.031)	-0.0966** (0.041)
$ComSize_{it-2}$	0.0021 (0.048)	0.0010 (0.042)
$ComIndep_{it}$	0.3129 (0.294)	0.4929 (0.385)
$ComIndep_{it-1}$	-0.4095 (0.323)	-0.3811 (0.355)
$ComIndep_{it-2}$	-0.1921 (0.429)	-0.1499 (0.455)
$ComNatDiv_{it}$	-0.0498 (0.496)	0.1822 (0.588)
$ComNatDiv_{it-1}$	0.7768* (0.450)	1.0963** (0.441)
$ComNatDiv_{it-2}$	0.1232 (0.289)	-0.1666 (0.429)
$ComTenureDiv_{it}$	0.0521 (0.181)	0.0647 (0.184)
$ComTenureDiv_{it-1}$	0.2860 (0.277)	0.3456 (0.300)
$ComTenureDiv_{it-2}$	0.2543 (0.173)	0.3183* (0.193)
ROA_{it}	-0.1184 (0.362)	-0.1605 (0.330)
ROA_{it-1}	1.2386* (0.686)	1.3414** (0.599)
ROA_{it-2}	-0.6615 (0.482)	-0.6516 (0.453)
$Firm\_Size_{it}$	0.6532** (0.314)	0.7023** (0.268)
$FirmAge_{it}$	-1.2143** (0.569)	-1.3148** (0.560)
$RevGrowth_{it}$	0.2065 (0.179)	0.1655 (0.156)
$Debt\_Level_{it}$	0.5435 (0.722)	0.6476 (0.654)
$CAPEX\_Level_{it}$	0.0095 (0.038)	0.0112 (0.033)
$Oper\_Perf_{it}$	-0.1085* (0.059)	-0.1251** (0.055)
$CashHold_{it}$	-0.6530 (0.545)	-0.6103 (0.482)

	$StratCom_{it}$	$StratCom_{it} \times (1 - CEO\_Power_{it})$
$FinSlack_{it}$	0.2471 (0.182)	0.2729* (0.156)
$OwnConcentr_{it}$	-0.0013 (0.033)	0.0042 (0.028)
$StateOwn_{it}$	0.1644 (0.920)	0.0209 (0.958)
$Big4_{it}$	0.1362 (0.173)	0.0969 (0.178)
CONST	-3.9354 (3.351)	-4.1280 (3.094)
Sargan test (p-value)	*27.9003 (0.0854)*	*24.2015 (0.1885)*
AR(2) (p-value)	*-0.0846 (0.9325)*	*-0.0598 (0.9523)*
Robust SE	*Yes*	*Yes*
Observations	*395*	*395*

Note: standard errors in parenthesis; statistical significance: *p<0.1 **p<0.05 ***p<0.01.

Source: created by the author.

Table 13. Two-step GMM Arellano-Bond dynamic panel data estimations for the impact of board committee members' experience on TSR

	SustCom*it*	SustCom*it*× ×(1 – CEO_Power*it*)	StratCom*it*	StratCom*it*× ×(1 – CEO_Power*it*)
TSR_{it-1}	0.0593 (0.073)	0.0655 (0.075)	0.1392* (0.072)	0.1606** (0.069)
$ComSize_{it}$	0.4261 (0.310)	0.6768* (0.383)	0.2013 (0.285)	0.3009 (0.376)
$ComSize_{it-1}$	1.1056* (0.665)	1.3688 (0.972)	0.5501 (0.407)	0.6277* (0.375)
$ComSize_{it-2}$	0.4548 (0.316)	0.4206 (0.544)	-0.5113* (0.310)	-0.7217** (0.305)
$ComIndep_{it}$	0.6561** (0.324)	0.9939** (0.421)	0.0776 (0.245)	0.0806 (0.298)
$ComIndep_{it-1}$	0.4507 (0.479)	-0.0655 (0.577)	-0.5475 (0.678)	-1.1124* (0.672)
$ComIndep_{it-2}$	-0.1206 (0.315)	-0.3534 (0.507)	-0.0578 (0.247)	0.0181 (0.292)
$ComNatDiv_{it}$	-0.5841** (0.234)	-0.8963** (0.351)	-0.1892 (0.243)	-0.0904 (0.298)
$ComNatDiv_{it-1}$	-0.4406** (0.352)	-0.6662 (0.436)	-0.1195 (0.299)	-0.4535 (0.354)
$ComNatDiv_{it-2}$	0.5490* (0.280)	0.5483* (0.316)	-0.1364 (0.189)	0.1022 (0.196)
$ComTenureDiv_{it}$	0.0522 (0.228)	0.0532 (0.292)	0.2374 (0.207)	0.3015 (0.258)
$ComTenureDiv_{it-1}$	0.1192 (0.310)	0.6595 (0.434)	-0.0503 (0.505)	0.1651 (0.486)
$ComTenureDiv_{it-2}$	-0.7830** (0.302)	-0.4810 (0.597)	0.2546 (0.280)	0.2976 (0.326)
ROA_{it}	0.2138 (0.300)	0.6189 (0.490)	-0.1353 (0.408)	-0.3534 (0.589)
ROA_{it-1}	0.1283 (0.412)	0.4274 (0.619)	0.2832 (0.587)	-0.1107 (0.730)
ROA_{it-2}	-0.3876 (0.362)	-0.6704 (0.407)	0.2396 (0.582)	0.4530 (0.849)
$Firm\_Size_{it}$	0.0539 (0.347)	-0.0303 (0.357)	-0.0505 (0.360)	0.1684 (0.350)
$FirmAge_{it}$	1.0535 (0.643)	1.1848* (0.648)	0.8812 (0.664)	0.8354 (0.689)
$RevGrowth_{it}$	-0.5999 (0.414)	-0.5916 (0.419)	-0.6736 (0.502)	-0.6217 (0.465)
$Debt\_Level_{it}$	0.3553 (0.234)	0.3902* (0.228)	0.5029* (0.301)	0.5294* (0.287)
$CAPEX\_Level_{it}$	-1.0687* (0.616)	-1.0799* (0.601)	-1.6157** (0.764)	-1.5386** (0.647)
$Oper\_Perf_{it}$	0.0898 (0.149)	0.0990* (0.157)	0.1982 (0.164)	0.1780 (0.157)

	SustCom*it*	SustCom*it*× ×(1 – CEO_Power*it*)	StratCom*it*	StratCom*it*× ×(1 – CEO_Power*it*)
$CashHold_{it}$	0.3318 (0.519)	0.1527 (0.520)	0.2360 (0.719)	0.6369** (0.725)
$FinSlack_{it}$	-0.0121 (0.030)	-0.0093 (0.030)	-0.0170 (0.035)	-0.0284 (0.034)
$OwnConcentr_{it}$	-0.0852 (0.053)	-0.0952* (0.055)	-0.0617 (0.063)	-0.0739 (0.062)
$StateOwn_{it}$	-0.5262 (0.488)	-0.4858 (0.509)	-0.3920 (0.540)	-0.5142 (0.482)
$Big4_{it}$	0.1582 (0.159)	0.1834 (0.189)	0.1131 (0.201)	0.1707 (0.190)
CONST	-0.0152 (0.026)	-0.0154 (0.026)	-0.0087 (0.033)	-0.0175 (0.029)
Sargan test (p-value)	-0.2307 (1.016)	-0.2628 (1.052)	-0.0575 (1.005)	-0.2435 (1.248)
AR(2) (p-value)	0.2053 (0.130)	0.1782 (0.131)	0.1485 (0.178)	0.1636 (0.161)
Robust SE	-0.5453 (2.219)	-0.8488 (2.298)	-0.4430 (3.731)	-1.1020 (3.139)
Observations	*26.6264 (0.1137)*	*26.8479 (0.1092)*	*27.2305 (0.0994)*	*23.8221 (0.2031)*
AR(2) (p-value)	*-0.4995 (0.6174)*	*-0.5291 (0.5967)*	*-0.2493 (0.8031)*	*-0.1617 (0.8715)*
Robust SE	*Yes*	*Yes*	*Yes*	*Yes*
Observations	*395*	*395*	*395*	*395*

Note: standard errors in parenthesis; statistical significance: *p<0.1 **p<0.05 ***p<0.01.

Source: created by the author.

It is noteworthy that the quality of regressions with TSR as the dependent variable is lower than the quality of regressions with Tobin's Q as the dependent variable. Specifically, regressions specified by Models 1a and 2a for the sustainability and audit committees suffer from invalid overidentifying restrictions (the null hypothesis of the Sargan test is rejected). Moreover, the Sargan test also demonstrates that overidentifying restrictions are not valid for Model 1a for the strategy committee (the null hypothesis is rejected at the 10% level). Consequently, I consider the results of constructing Model 2a only for the strategy committee, indicating that greater strategy committee size has a slight negative impact on TSR, while a higher share of foreign members in the strategy committee has a significant positive impact on TSR (the coefficient 1.0963 with a 1-year lag is significant at the 10% level).

As for regressions specified by Models 1b and 2b (i.e., education diversity), the Sargan test (overidentifying restrictions) and the Arellano-Bond test (serial correlation in the first-differenced errors in orders 1 and 2) reject the null hypotheses; consequently, the results of these regressions cannot be taken into account.

As expected, the quality of regressions is higher for sustainability and strategy committee professional experience. Both Models 1c and 2c presented in Table 13 demonstrate that a higher proportion of sustainability committee members with professional experience in finance significantly contributes to TSR. Interestingly, a higher proportion of sustainability committee members with experience in technical fields leads to higher TSR, while a higher concentration of members with industry-specific experience, on the contrary, has a negative impact on TSR. A higher concentration of sustainability committee members with experience of being a CEO (or its equivalent) negatively affects TSR; however, this effect is mitigated by a powerful CEO. As for the strategy committee, there is a negative impact of its members' experience in finance on TSR, which is mitigated by a powerful CEO. Finally, the regressions for audit committee members' professional experience were not included in Table 13 as they failed to pass the Sargan and Arellano-Bond tests. The overall results of econometric analysis are summarized in Table 14.

Table 14. Summary of econometric analysis results

Board committee characteristics and expected effects	Committee	Findings: Tobin's Q	Findings: TSR
H1. A higher board committee independence level, ceteris paribus, enhances corporate financial performance			
Independence level (+)	Sustainability committee	Not supported	Not supported
	Strategy committee	Not supported	Not supported
	Audit committee	Not supported	Not supported

Board committee characteristics and expected effects	Committee	Findings: Tobin's Q	Findings: TSR
H2. Greater board committee tenure diversity, ceteris paribus, enhances corporate financial performance			
Tenure diversity (+)	Sustainability committee	+*	Not supported
	Strategy committee	Not supported	+*
	Audit committee	Not supported	Not supported
H3. A higher share of foreign directors in board committees, ceteris paribus, enhances corporate financial performance			
National diversity (+)	Sustainability committee	Not supported	Not supported
	Strategy committee	Not supported	+**
	Audit committee	Not supported	Not supported
H4. A higher level of board committee education diversity, ceteris paribus, enhances corporate financial performance			
Educational level diversity (+)	Sustainability committee	+**	Not supported
	Strategy committee	Not supported	Not supported
	Audit committee	Not supported	Not supported
Major diversity (+)	Sustainability committee	Not supported	Not supported
	Strategy committee	Not supported	Not supported
	Audit committee	Not supported	Not supported
H5. Different types of board committee professional expertise, ceteris paribus, enhance corporate financial performance			
Experience in finance (+)	Sustainability committee	+*	+*
	Strategy committee	Not supported	+* (1-year lag) –* (2-year lag)
	Audit committee	Not supported	Not supported
Experience in a technical field (+)	Sustainability committee	Not supported	+**
	Strategy committee	–*	Not supported
	Audit committee	Not supported	Not supported
Industry-specific experience (+)	Sustainability committee	–*	–**
	Strategy committee	Not supported	Not supported
	Audit committee	Not supported	Not supported
Experience of being a CEO (+)	Sustainability committee	–*	–**
	Strategy committee	Not supported	Not supported
	Audit committee	Not supported	Not supported
Experience in state-services (+)	Sustainability committee	+**	Not supported
	Strategy committee	Not supported	Not supported
	Audit committee	+*	Not supported

Board committee characteristics and expected effects	Committee	Findings: Tobin's Q	Findings: TSR
H6. A higher level of CEO power, ceteris paribus, mitigates the positive effects of board committee human capital on financial performance			
	Sustainability committee	Supported	Supported
	Strategy committee	Not supported	Not supported
	Audit committee	Supported	Not supported

Source: created by the author.

Having presented the empirical findings, let us now discuss their implications for understanding the role of board committees in shaping corporate financial performance in Russia.

Discussion

In this paper I analyze the impact of the characteristics of key board committees – the audit, strategy, and sustainability committees – on corporate financial performance measured by market-based indicators (Tobin's Q and TSR) and the moderating role of CEO power. Although there is a number of papers investigating the impact of corporate governance characteristics on the financial performance of Russian companies [3; 5–7; 82], they mostly focus on overall board characteristics without considering board committee composition and human capital characteristics. Some papers investigate the impact of board committee characteristics on corporate performance in both developed and emerging markets [37; 60; 66; 68]. However, they mostly focus on audit committee characteristics (for example, size, independence, and the share of directors with financial expertise) and rarely study board committee diversity in terms of human capital such as education and professional experience. This paper contributes to the existing literature in this field.

Many papers that consider board committee characteristics include committee independence in their models. Unlike most of them, I have not confirmed a significant impact of board committee independence on corporate performance. Some papers considering board members' independence explain the insignificance of its impact on corporate performance by higher busyness [22; 92]. This difference may also be attributed to the overall corporate governance environment in Russia. Higher ownership concentration, higher share of state ownership and top-management power hinders the monitoring role of boards, making directors' independence a less significant factor than their specific knowledge and ties [4; 93]. These results do not support Hypothesis 1, highlighting the importance of considering local market characteristics when evaluating the effects of corporate governance practices.

At the same time, my findings partly support Hypothesis 2, demonstrating a positive impact of board sustainability and strategy committee tenure diversity on market-based financial performance indicators, which is in line with previous findings [63; 80]. Diversified board committees in terms of members' tenure accumulate not only different types of knowledge and experience, but also different views on the company – the views of "centenarians" aware of firm-specific issues and "newcomers" with a fresh perspective. Tenured directors possess accumulated firm-specific knowledge, allowing them to perform both advisory and monitoring functions more effectively [10; 63], which is in line with the *resource-based view*. Moreover, co-tenure of board committee members mitigates the negative effects of board expertise and background diversity [57].

The results of econometric analysis partly support Hypothesis 3 by demonstrating the positive impact of strategy committee national diversity on market-based financial performance indicators. This is in line with some previous studies of the Russian market [3], and may be explained from the *resource-based view* perspective, as foreign directors bring knowledge and experience which can hardly be found on the local corporate governance market, as well as social ties with foreign stakeholders [16; 49]. However, it should be emphasized that unique knowledge and experience obtained in foreign companies and institutional environments may be acquired by domestic board members studying or working abroad [30], which makes further research necessary.

As for the education diversity of board committee members, Hypothesis 4 about its positive impact is partly supported only for the sustainability committee, where members with different levels of education (undergraduate, graduate, MBA, PhD, Candidate of Sciences, Doctor of Sciences) contribute to higher Tobin's Q, which is in line with the *resource-based theory* [54]. Companies with more educated board members tend to implement more risk-averse strategies and practices by enhancing financial resilience [94] and company liquidity [95], thus making the company more attractive to investors. However, the overall weak impact of board committee education diversity on corporate financial performance is in line with some previous results [96] and may be explained by a lack of industry-specific and firm-specific knowledge in certain industries.

According to the obtained results, the professional experience of board committee members has the most significant contribution to corporate performance. I show that the professional experience of strategy and sustainability

committee members in finance significantly contributes to corporate financial performance, while, for the audit committee with greater a representation of this type of experience, this effect is not statistically significant. This is in line with results of some previous studies stating that the diversification (or *breadth*) of board members' professional experience contributes more to corporate innovativeness and overall performance rather than a higher proportion (or *depth*) of certain types of experience [44; 86]. Additionally, a higher proportion of members with professional experience in finance in "non-financial" board committees may prevent companies from overinvestment or, in other words, improve the investment efficiency of company [97].

The findings also show that industry-specific experience and the experience of performing CEO (or equivalent) functions are mostly an insignificant or even a negative factor for the sustainability committee. These findings partly contradict Muravyev [3] but may be explained by the negative effect of the concentration of certain types of experience, narrowing the spectrum of information and approaches used to make decisions. At the same time, a higher share of directors with experience in public service in the sustainability and audit committees contributes to Tobin's Q, as such directors may broaden company access to resources thanks to their professional ties [8; 9; 84]. Thus, the results partly support Hypothesis 5.

Finally, the results confirm that a higher level of CEO power mitigates certain effects of board committee characteristics on corporate performance, which is in line with Hypothesis 6, formulated on the basis of the findings of Hayness and Hillman [44] and more recent findings for emerging markets [8]. Powerful CEOs influence the implementation of decisions made by boards, and can both constrain the implementation of positive initiatives [98] and mitigate the negative effects of non-optimal decisions [57]. However, according to the existing literature, powerful CEOs contribute to corporate performance in the case of a more powerful *monitoring* role of the board [43; 99], suggesting that the board's power should be enhanced by mandating clear rights and powers in corporate charters and regulatory documents [100].

To sum up, the results demonstrate that board committees are not homogeneous in terms of the effects of their composition on corporate performance. It is shown that board professional experience diversity is the most significant factor, albeit it can be deterred by a powerful CEO. Additionally, by highlighting both similarities and differences with previous research, new insights are offered into the complex dynamics of corporate governance and its effects on financial outcomes of Russian corporations.

Conclusion

The results of this study demonstrate that board committee characteristics significantly affect corporate financial performance of Russian public non-financial companies. These findings have several important implications for practitioners and policymakers in Russia and similar emerging markets in the context of the massive changes in corporate governance structure in Russian companies after the sanctions imposed in 2022–2023. Companies should consider diversifying expertise within their board audit committees beyond traditional financial and legal backgrounds to include members with experience in technical fields, public service and other non-financial fields. Further diversification is necessary for strategy and sustainability committees, as a higher level of diversity can provide a broader perspective and enhance decision-making processes. These implications are valuable for both currently listed companies seeking to optimize their board committee structure and private companies preparing to go public in line with the current IPO boom in Russia [101].

As for policymakers, regulatory bodies should consider developing and implementing guidelines that encourage or require board committee diversity, including recommendations for members' professional and educational backgrounds. Additionally, the study demonstrates the need for enhanced disclosure requirements regarding board composition and members' roles, enabling stakeholders to assess the effectiveness of corporate governance practices in promoting financial performance.

Although this study provides valuable insights, it also has some limitations. Firstly, the sample is limited, covering only the period before the crisis of 2022, when a number of foreign directors and some influential Russian directors left corporate boards. Secondly, the paper does not consider several important types of professional experience such as experience in R&D fields or the experience of being a university professor or researcher. Thirdly, there is no comparative analysis of knowledge and experience brought by internal and external (foreign, independent) board members. Finally, variables of board social capital are not included in the models, albeit there is evidence that board members' professional ties contribute to corporate performance and value [102–104]. Further research on the dataset of Russian companies is necessary to bridge these gaps.

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Appendix

Appendix 1. Description of variables

Variable notation	Variable description
Dependent variables (FinPerfit)	
TobinsQ*it*	Tobin's Q of company *i* in the year *t*
TSR*it*	Total Shareholder Return (TSR) of company *i* in the year *t*
BoardComCharactaristics – 11 variables representing characteristics of following board committees: *audit*, *strategy*, *sustainability* (*ESG*) committees. Following previous studies [49; 105], I apply Blau index [106] to evaluate diversity.	
ComTenureDiv*it*	Tenure diversity of committee members. I use 5 groups, depending on the number of years on board: group 1 (0;3), group 2 [3;5], group 3 (5;10], group 4 (10;15], group 5 (15;+). Using these groups, I build Blau index: ComTenureDiv*it* = 1 – $\sum p(\text{Group}g)^2$, *g* from 1 to 5
ComEduLevDiv*it*	I use 5 levels of education of committee members – 1 (undergraduate), 2 (graduate), 3 (MBA), 4 (PhD/candidate of sciences), 5 (doctor of sciences), – and calculate Blau index: ComEduLevDiv*it* = 1 – $\sum p(\text{Group}g)^2$, *g* from 1 to 5
ComEduMajorDiv*it*	I use 6 majors – Economics, Finance and Accounting, Management, Law, Technical sciences, Humanitarian sciences – and calculate Blau index: ComEduMajorDiv*it* = 1 – $\sum p(\text{Group}g)^2$, *g* from 1 to 6
ComFinExp*it*	The **percentage** of committee members who have an experience of work in finance and audit, in banking and financial services.
ComTechExp*it*	The **percentage** of committee members who have an experience of working in technical services (engineering, technical support, etc.).
ComIndExp*it*	The **percentage** of committee members who have an experience of work in the same industry as a Board member (in another company) or executive.
ComCEOExp*it*	The **percentage** of committee members who have an experience of being CEO / partner in consulting / minister / rector.
ComStateExp*it*	The **percentage** of committee members who have an experience in public services.
ComNatDiv*it*	Share of foreign committee members.
ComSize*it*	Natural logarithm of the number of committee members.
ComIndep*it*	Share of independent committee members.
CEO Power I build CEO Power index by **summarizing** following three metrics with coefficients equal to 1/3:	
CEO_Tenure*it*	Dummy-variable, equals 1, if CEO tenure is greater than average for the sample, 0 – otherwise.
CEO_Board*it*	CEO's participation in key board committees: strategy, remuneration, and sustainability committee, varying from 0 (CEO does not participate in Board committees) to 1 (participates in all committees).
CEO_Own*it*	Dummy-variable, equals 1, if CEO's share in ownership is greater than average for the sample, 0 – otherwise.
Firm parameters	
Firm_Size*it*	Natural logarithm of total assets (in mln RUR) of company *i* in the year *t*.

Variable notation	Variable description
FirmAge*it*	Natural logarithm of age (in years) of company *i* in the year *t*.
RevGrowth*it*	Revenue growth rate for company *i* in the year *t*.
Debt_Level*it*	Financial leverage, determined by formula: $Debt\_Level_{it}$ = Total Debt Book $value_{it}$ / Total Assets Book $value_{it}$
CAPEX_Level*it*	This parameter is determined by formula: $CAPEX\_Level_{it} = CAPEX_{it} / Revenue_{it}$
ROA*it*	Return on assets of company *i* in the year *t*.
Oper_Perf*it*	Company's operational performance determined by formula: $Oper\_Perf_{it} = EBITDA_{it} / Revenue_{it}$
CashHold*it*	Cash holding level of company *i* in the year *t* calculated as: $CashHold_{it} = Cash\&Equivalents_{it} / Revenue_{it}$
FinSlack*it*	Financial slack, representing financial resilience of company *i* in the year *t*, calculated as: $FinSlack_{it} = (Cash\&Equivalents_{it} - CurrentLiabilities_{it}) / Revenue_{it}$
OwnConcentr*it*	I determine ownership concentration in company *i* in the year *t* [66, 93]: $OwnConcentr_{it} = \ln(TOP3\ Owners\ Share_{it} / (1 - TOP3\ Owners\ Share_{it}))$ *TOP3 Owners Share* – share of 3 largest shareholders in company's ownership.
StateOwn*it*	State's share in ownership of company *i* in the year *t*.
Big4*it*	Dummy-variable, equals 1 if annual report of company *i* in the year *t* is assured by one of the Big4 audit companies (Deloitte, EY, KPMG or PwC), 0 - otherwise.

Source: created by the author.

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Determinants of Financial Performance of Business Ecosystems in Russia

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Abstract

The scientific literature provides a comprehensive description of business ecosystems and their key advantages. However, there is a lack of thorough exploration into the practicality and efficacy of implementing business ecosystems, as well as strategies to enhance their economic impact. This study examines the impact of three key factors on the effectiveness of business ecosystems: ecosystem self-sufficiency, service integration, and customer satisfaction. A sensitivity analysis of the Net Present Value (NPV) of ecosystems was conducted using discounted cash flow models for two leading Russian technology companies, IC PJSC Yandex and IC PJSC VK. The analysis focused on key drivers such as the number of active clients, average customer churn rate, digital sales funnel, and average transaction value. Ecosystem self-sufficiency significantly and variably affects NPV, with the removal of even a single business line leading to a negative impact on ecosystem value (ranging from –5 to –167%). The level of service integration has a minor influence on ecosystem NPV, with a 50% variance in subscription users leading to an NPV deviation of no more than 16%. Customer satisfaction, however, can have a substantial positive effect on ecosystem NPV, with a 1% improvement in satisfaction leading to a potential 3.7% increase in NPV. From the point of view of scientific novelty, this study allows to conclude that each factor of the effectiveness of ecosystem implementation is associated with the ability to collect and use information. For the Russian technology sector, a significant impact was identified in two of the three key factors: ecosystem self-sufficiency and customer satisfaction. The practical significance of the results of this study lies in determining the general factors that show under what conditions the introduction of an ecosystem is economically justified for the technology sector.

Keywords: digital business ecosystems, business ecosystems, valuation of business ecosystems, business development, business strategy

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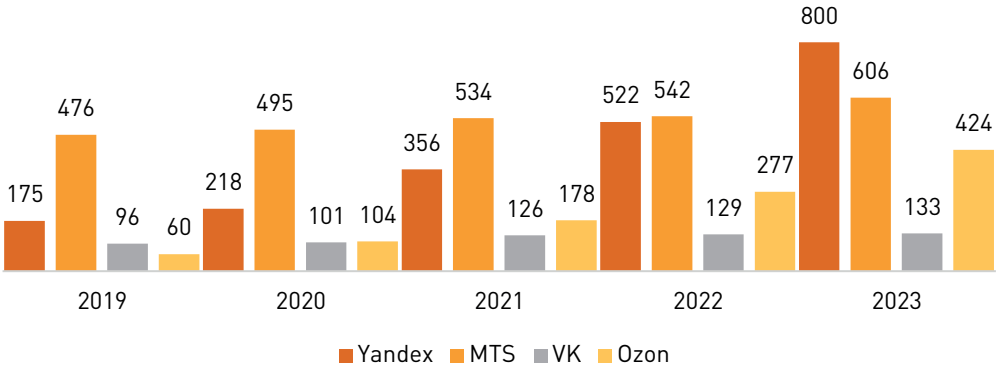
Figure 1. Revenue of the largest Russian non-financial ecosystems, bln. rub.



Source: smartlab.ru

Introduction

Over the last 10 years the majority of large Russian companies have announced the development of their own business ecosystems. In banking, telecommunications and, first and foremost, technology some of them have used the lead building business models based on the ecosystem principle [1].

For example, Yandex and Ozon are large Russian technology companies, which managed to increase their revenue more than four-fold between 2019 and 2023 (Figure 1). Using an extensive technological base combined with an aggressive investing policy the companies built a stable business model capable of expanding to numerous segments of the Russian technology market. However, some ecosystems, for instance MTS and VK, have not harnessed the growth potential of this business model to the full extent: in 5 years their revenue growth did not exceed 50%. In this respect the problem of searching for factors that explain such a substantial difference in the effect from ecosystem implementation is significant from the practical point of view because it will allow Russian companies to use the existing resources in a more efficient manner when building their business models.

The majority of prosperous Russian business ecosystems were based on existing companies in a certain industry. According to the currently relevant definition [2], a business ecosystem is a company development strategy that entails offering a range of complementary products and/or services which create additional value for the customer.

The coronavirus pandemic was the first significant trigger for business integration into a combined business environment. It forced companies to develop digital sales channels in order to survive a slump in consumer demand.

Sanctions produced a mixed influence on the development of Russian ecosystems [3]. On the one hand, a lack of access to advanced developments of mature economies significantly limits the development of digital business ecosystems. Entry into foreign markets, even friendly ones, is also restricted due to the secondary sanctions risk. Media services have been denied access to foreign information content, which results in significant limitations of sustainable development of digital ecosystem businesses. On the other hand, Russian digital ecosystems continue to develop driven by restrictions on foreign technology, among other things: in order to survive under the pressure of new realities companies have to create cooperation channels in the research and development sphere. Withdrawal of foreign companies from Russia offers prospects for the development of domestic technological solutions. Companies are capable of creating such solutions as a part of building closer relationships and establishing business ecosystems.

The most important and rapidly developing ecosystems operate in the following five industry sectors: banking, IT, telecommunications, retail and classifieds [4]. As the ecosystem develops, the boundaries between industries are erased: banks establish non-banking services, non-financial sector creates its own fintech services.

The key unique characteristics of Russian business ecosystems are as follows [5]:

- the majority of ecosystems are at the stage of emerging and development, which manifests itself as untapped potential and probable development of this cooperation form in the future;
- combines the features of transactional and solution ecosystems; classified as a hybrid business ecosystem;
- predominance of earnings from the core business in the revenue structure, which provides an opportunity to develop new business lines using the generated cash flows.

Apart from the above-listed unique characteristics, we should emphasize the prime advantages for Russian companies provided by the business strategy based upon the ecosystem approach:

1) Maintaining and enhancing loyalty of active clients.
2) Expanding the client base by entering "neighboring" and "distant" markets.
3) Generating more revenue from the core business by creating an inflow of users from related business lines.
4) Business diversification.
5) Enhancing business resilience by increasing flexibility of the investment strategy.

6) Search for new potential lines of business development based on customer information.

Enhancing business resilience by increasing flexibility of the investment strategy means that the company is able in a timely manner to get rid of "unnecessary" services that have a detrimental effect on financial performance and are incapable of providing economic benefits in the future due to changes in the external environment or integrating new, most promising projects rapidly. Based on the analysis of the information about a customer, the company can build a more flexible investment strategy, adapting to the newest trends, thus enhancing the investment attractiveness of the business ecosystem. For example, in 2022–2023 Russian business ecosystems closed down 37 loss-making projects and launched 67 new ones [6]. Due to a rapid response to sudden changes in the external environment, business ecosystems are able to enhance business resilience and make more efficient use of their resources based on data analytics.

A turbulent Russian macroeconomic environment makes large companies diversify their project portfolio, but in order to build a flexible investment strategy integration of interrelations between business lines should be enhanced, thus ensuring the efficient use of customer information.

However, apart from distinct advantages, there are also disadvantages. Thus, the creation of a business ecosystem may affect the company in a negative way. For example, if a business ecosystem offers a range of goods and services intended for antagonistic user target groups, offering one product and/or service which comes with another product may cause loyal customer churn because the consumer is unwilling to pay for something he does not need. Some scientific ecosystem studies show that just 15% of them attain the "leadership" stage [7].

Companies that are most effective at collecting and using customer information gain the biggest advantage from the implementation of an ecosystem. The more a company knows about the customer, the more suitable is the set of goods and services that the ecosystem can offer him.

Development of digital technology and its growing availability allows ecosystems to make more efficient use of information about the customer. However, far from all companies are able to implement and use effectively this technology. Technological business ecosystems have to spend rather serious resources on marketing, development of applications and web sites, as well as data storage. Few companies can do it without external assistance. The problem of relevance and efficiency of building a proprietary ecosystem is of practical importance a Russian company because Russian large and medium businesses exhibit investment activity in this area.

The purpose of this paper is to study the key factors that define the efficiency of implementing the ecosystem approach for Russian business using Russian public technology companies as an example.

The main research problem raised in this study is the search, detection and analysis of the key factors that allow ecosystems to gain a competitive advantage over other business models using Russian technology companies as an example.

This research considers the influence of three different factors on the financial performance of certain business lines within the same business ecosystem and on determining the value of the ecosystem itself by applying the DCF method and using two Russian technology companies – IC PJSC Yandex and IC PJSC VK – as an example. This is the first paper to conduct and present a qualitative analysis of influence of the key factors of a business ecosystem's development efficiency and quantitative evaluation of the impact of these factors on the business ecosystem value. This research focuses on assessing the value of a business as a business ecosystem using the drivers that describe the interrelation between the elements of this ecosystem, rather than a holding with several business lines, whose value is equivalent to the sum of individual unrelated values of these business lines.

The paper consists of three parts. The first part presents a review and analysis of the academic literature, which demonstrates the existing results of research papers and reveal the relevant understudied research issues on our topic. The results of qualitative analysis presented in the existing academic papers allow us to make an assumption about the potential key factors of efficiency of the ecosystem approach implementation in the classic business model. The second part determines the factors that influence the efficiency of business ecosystem implementation on the basis of analyzed sources and statistical data, and also presents the research methodology. The third part lays down the research results and their scientific and practical importance.

Theoretical Foundations of a Business Ecosystem

In academic literature there are several avenues for examining a business ecosystem. The studies of the first type focus on defining the business ecosystem phenomenon and its unique characteristics as compared to other forms of market participants' interaction. The second research line addresses the objective of revealing various types of ecosystems, their classification depending on legal relationships between participants, ways of interaction, etc. The third line of research is based on comparison of business ecosystems at the country, industry and individual company level. In order to perform a critical analysis, we should consider the definition of a business ecosystem.

Definition of a Business Ecosystem

The term "business ecosystem" was introduced and studied in detail by the scientists J.F. Moore and M. Rothschild [8–11]. In their papers the term "business ecosystem" is defined as a community of interacting organizations and individuals involved – the organisms of the business world. The authors point out the main difference in the principle of company operations in a business ecosystem. A company is considered as a part of the shared business ecosystem involving a lot of industries, rather than a participant

of certain markets. Interindustry relations form the main trigger for the emergence of a business ecosystem, similarly to an ecosystem in biology [12].

The most important research issue in defining an ecosystem is related to its ability to create greater value for the customer than an individual firm. R. Adner writes the following in his research paper: "When they work, ecosystems allow firms to create value that no single firm could create alone" [13]. Study of the game console market development shows that a winning position in the complementary goods markets is not guaranteed by creation of the best product. It is the creation of matching products and offering them as a package that allows technology companies to get loyal customers and obtain a long-term competitive advantage. Investment of resources by different companies and organizations within an ecosystem results in the creation of common value for the consumer, thus leading to a higher customer satisfaction [14].

The most up-to-date sources define a business ecosystem as a purposeful business arrangement between two or more market players to create and share collective value for a common set of customers [15]. The brands of all members of a business ecosystem are presented in the value propositions. Every ecosystem has several participants and at least one orchestrator. The concept of a modern business ecosystem implies joint coordination of all participants' actions by orchestrators related to business agreements, market positioning strategies, value creation and sharing mechanisms as well as ecosystem risk management.

The life cycle of a modern digital business ecosystem is divided into 4 stages: foundation, expansion, leadership and self-renewal (otherwise it is death) [16]. For a company, implementation of an ecosystem is accompanied by challenges. Some of them are relevant not only for ecosystem businesses: demand generation in the absence of supply or the reverse situation, uncontrolled cost growth at the scaling stage when network effects emerge, control of product quality in the period of explosive growth as well as competition with copies of the platform when the barrier for market entry is low. The authors emphasize that the management methods used for conventional businesses are not suitable for business ecosystems. It is impossible to preplan or pre-engineer an ecosystem. It develops and evolves as a living organism, adapting to users' rapidly changing preferences and needs.

Four parameters form the basis of an ecosystem: modularity, customization, multilateralism, and coordination [17].

Modularity means the possibility of independent development of a product by each ecosystem model member. Then it is integrated into the common network of ecosystem products that complement each other.

Customization implies the integration of each product into the common value proposition. In other words, each new product complements the product already presented to the user.

Multilateralism of ecosystem members means that their relations cannot be reduced to bilateral interactions because each member interacts with several other ecosystem members simultaneously. A member breaking off relations with one ecosystem participant loses their relations with others.

Coordination indicates that interaction between ecosystem participants is regulated by generally accepted standards and processes, but is not strictly regimented as in a hierarchical structure.

A business ecosystem combines the features of an open market and a vertically-integrated organization where all processes depend on a certain system participant. A business ecosystem is on the one hand a decentralized segmented system, but at the same time interactions between its participants are highly coordinated.

Any ecosystem is based on a compelling value proposition. In order to assess the prospects for ecosystem implementation, first of all, it is necessary to evaluate the opportunities offered by the market situation, rather than company characteristics because the ecosystem approach may also comprise the integration of various market participants. In such a case a company does not need to raise large amounts of funding: each participant makes its contribution.

Based on our literature analysis, we may conclude that the problem of defining a business ecosystem as an individual type of a business model has been raised in science rather recently and is still relevant. The reason is the explosive development of digital technology and the accompanying development of inter-industry relations.

The diversity of inter-industry relations caused by rapid digitalization has opened up an opportunity to create different forms of business ecosystems. The scientific problem of classification of these cooperation forms within the ecosystem approach is also of relevance.

Types of Business Ecosystems

Apart from the importance of providing a definition of a business ecosystem and comparison of this business model type with other possible forms of inter-company cooperation, academic literature classifies business ecosystems on the basis of various features.

Interaction of market participants within the same ecosystem may be attributed to one of 5 types based on their relationships and legal dependence on each other [18].

The authors observe that this classification of business ecosystems is established with consideration of the level of closeness of ecosystem participants' interaction. Commodity supply chains imply the minimum interaction level, while newly integrated companies imply the maximum level of closeness and involvement of participants within the ecosystem in order to create a shared value for the customer.

There is an ecosystem classification based on the mode of participants' interaction [19]. BCG experts distinguish two types of business ecosystems: the transactional ecosystem and solution ecosystem.

The authors also point out that it is possible to create a hybrid ecosystem. For example, Apple built a solution ecosystem from the very start. However, after it founded its own

app store, the ecosystem was able to operate as a transactional one. This implies that the company's business model may be classified as a hybrid ecosystem.

Experts of the McKinsey & Company consulting firm defined 6 different models of business ecosystems depending on the strategy of interaction with the customer and/or asset allocation: the acquisition engine model, platform business model, multibusiness ownership model, data monetization model, asset and resource synergy model and infrastructure and capability enabler model [20]. The acquisition engine model, platform business model, multibusiness ownership model and data monetization model allow to increase the revenue by achieving a synergy of various business lines. The asset and resource synergy model and the infrastructure and capability enabler model imply a synergetic effect of spending optimization and, consequently, business performance enhancement.

Table 1. Classification of Ecosystems

Classification author	Cambridge	BCG	McKinsey & Company
Classification criterion	Legal dependence	Economic relationship	Customer interaction and/or asset allocation
Parameter of the relation between the elements	Level of closeness of participants' interaction	Direct and indirect network effects/quality control or technology	System of coordination and control of assets/product quality/customer interaction
Type according to the classification	Commodity supply chains	Transactional ecosystem	Acquisition engine model
	Bilateral relationships		Platform business model
	Multilateral relationships	Solution ecosystem	Multibusiness ownership model
	New company		Data monetization model
	New integrated company	Hybrid model	Asset and resource synergy model
			Infrastructure and capability enabler model

Thus, as a part of this scientific problem we may distinguish three different types of ecosystem classification based on various modes of element interrelations: Cambridge – legal dependence, BCG – economic relations, McKinsey & Company – customer interaction and/or asset allocation (Table 1).

The fundamental scientific problem of ecosystem classification arises out of scientific studies of business ecosystem development at the regional, national and industrial level, as well as the study of the individual business ecosystem experience .

Review and Comparison of an Ecosystem Business Model at Different Levels

The research papers dedicated to the comparison of business ecosystems may be divided into three main subcategories: analysis of business ecosystem development at the country level, relevance of business ecosystem implementation at the industry level and comparison of the effectiveness of business ecosystem implementation on the basis of analysis of individual companies' experience.

The first subcategory of academic literature comprises the papers dedicated to a greater extent to experience of companies in ecosystem implementation and the prospects for development of this business model with regard to regulatory and market-specific features of certain countries.

The most relevant foreign papers on business ecosystem development in certain regions mainly describe the experience of emerging countries. For example, the paper by L. He, Y. Cheng, X. Su covers the problem of business ecosystem development in China [21]. Based on Chinese companies' experience the authors revealed that defining the "boundary barriers", construction of a dynamic business model and unlocking a company's potential are the key factors of sustainable ecosystem development.

Defining "boundary barriers" implies identification of negative factors which impact the independent functioning of an individual company. For example, in the energy sector the authors revealed three factors: technological, product and productive. To develop technology, improve product quality and raise productivity companies have to create relationships similar to the ones formed by biological organisms within an ecosystem: aggregation and integration of company resources as a part of ecosystem cooperation allows to diminish the negative effect of "boundary barriers".

In the authors' opinion, exchange and use of information related to customer needs (external communications) in addition to just technology makes cooperation more effective.

Analyzing the prospects of ecosystem development, the author indicates significant limitations of business ecosystem development in India due to the gap between sociocultural and government institutions, placing special emphasis on the specific features of the created business environment [22].

The problem and prospects of business ecosystem development in Russia have been raised repeatedly in scientific research literature [23–28]. The authors of academic papers have considered ecosystems from the viewpoint of different levels and approaches: regulation, management and general principles of participants' interaction. Scientific papers also point out the importance of development of regional business ecosystems against the background of development of a country's individual regions.

The most relevant study of Russian ecosystems offers an insight into the trends and prospects for business ecosystem development with regard to Russian business environment specifics, especially when the Russian economy faced partial isolation related to trading with a range of countries that are advanced from the point of view of technological development [29].

The authors define three strategies of ecosystem implementation on the basis of Russian companies' experience: development of their own services (Yandex, Sber and MTS) using the existing corporate resources, entering into partnerships with other services (Tinkoff Bank) and the hybrid strategy (VK).

The authors of the abovementioned paper place the greatest emphasis on distinctive features of ecosystem regulation. Instead of antitrust regulation, the regulator focuses mostly on protection of personal data and consumer rights as well as service providers' non-discrimination.

The most common strategy for linking users within the same ecosystem that allows to offer supplementary services and products is a general subscription option. This offer enjoys the greatest popularity with Yandex and MTS users. However, the potential of this strategy has not been fully realized in the Sber and VK ecosystems.

The authors concluded that existing Russian business ecosystems are at the foundation stage and have not fulfilled their potential. The main positive effect of ecosystem implementation is the distribution of technologies and solutions among services that allow to develop them faster by means of creating better innovative products and enhancing customer satisfaction.

The satisfaction of each customer depends on ecosystem capability to determine customer preferences. Thus, the key driver of ecosystem development is the ability to collect, store and use information about the customer [30].

The second subcategory of academic literature is dedicated to relevance of business ecosystem implementation in certain industries.

Implementation of a digital business ecosystem may exert a positive impact in healthcare [31]. In spite of the obvious benefits arising out of ecosystem implementation, the authors revealed the main obstacles to development of this form of companies' cooperation. The major challenge of ecosystem implementation consists in the ability to coordinate and control the participants. The key factors that determine the ecosystem resilience include diversity, efficiency, adaptability and management cohesion.

Implementation of digital technologies and organizing interaction among market participants according to the business ecosystem principle may also be effective in the agroindustrial complex [32–33]. The key driver of this cooperation form is the technological solution exchange between the ecosystem participants because a significant technological gap between participants has a detrimental effect on productivity parameters and the industry in general. Construction of an ecosystem on the basis of an agricultural bank allows to solve the complex strategic task of developing Russia's agroindustrial complex. Development of complementary banking products based on the experience of customer interaction enhances the resilience of the core business and opens up new opportunities for further growth,

The business ecosystem concept may be applied to consider the interaction of certain regional economic zones [34]. The authors of this research set the goal to define the key characteristics of the companies that pertain to regional business ecosystems using the Italian machine building industry as an example in order to calculate the extent of influence of local conditions on the management, competitiveness and nature of interrelations. The research results show that company affiliation with a regional ecosystem allows to gain an advantage related to access to innovation and to ensure high product quality through close cooperation and exchange of information with each ecosystem participant about the characteristics of a certain type of components.

The third subcategory of academic research literature comprises the papers on comparison of effectiveness of various business ecosystem forms using certain companies as an example.

One of relevant studies of the business ecosystem concept using certain technology companies as an example is dedicated to the experience of Amazon [35]. The key characteristic feature of Amazon's business strategy is a combination of different approaches and practices. On the one hand, this technological giant combines the single company concept, controlling all main business processes. On the other hand, the company enters into a range of partnerships which allow it to integrate products and services of unrelated parties into its services. By combining these strategies, the company becomes a conductor of infrastructure for its partners and a forming unit for the comprehensive value proposition to the customer. Expanding its own range of products by means of engaging partners and its own products, the company expands the set of prospective customers, gaining a competitive advantage in the electronic commerce market.

One of the most relevant modern studies of business ecosystems compares two different technological digital platform concepts: Huawei HarmonyOS and Xiaomi Smart Home [36]. The main difference between these digital business ecosystems is defined by technology. Huawei HarmonyOS was created as an open business ecosystem concept, while Xiaomi Smart Home is a closed system focused on development of its own branded technological solutions. In the authors' opinion, the first concept may be more effective in the long term, while in the short term heightened control over participants' interaction is necessary. The second strategy may be effective in the short term due to the rigid coordination of interaction between participants. However, in the long term this strategy may lose its competitive advantage.

1) Comparison and detection of distinctive features of business ecosystems at the regional (country) level.
2) Comparison and relevance of business ecosystem implementation at the level of individual industries.
3) Comparison and detection of distinctive features of business ecosystems using individual companies as an example.

A fairly large number of relevant research papers have tackled the topic of business ecosystems. Qualitative methods of factor evaluation are mainly applied to assess the relevance of ecosystem implementation. The key factor that influences the efficiency of ecosystem implementation is the ability to collect, process and use customer information provided by each participant in order to improve the product at each link of the value chain or to develop a complementary product or service that enhances customer satisfaction.

However, the problem of efficiency of business ecosystem implementation and the factors determining it, as well as quantitative evaluation of these factors have been understudied.

Scientific novelty of the present research consists in a more detailed study of the insufficiently explored problem, namely the definition and quantitative evaluation of the impact made by the key factors – the effectiveness of creation and integration of the ecosystem approach into an existing business.

Most business ecosystem studies have limitations related to the applied qualitative analysis methodology. The quantitative analysis elements used in some papers do not completely reveal or validate the results of qualitative analysis. In the present paper quantitative analysis is used in conformity with qualitative analysis.

Research Methodology

Defining the Factors which Impact Efficiency of Business Ecosystem Implementation

On the basis of analysis of academic literature and other sources one may make the conclusion that company ability to collect, process and use information on customer preferences is the key factor which determines development of a business ecosystem.

The present research considers three parameters that influence the effectiveness of collecting, processing or use of customer information (Table 2).

Table 2. Factors of Effective Ecosystem Development

Factor	Influence on efficiency of data collection and processing	Influence on efficiency of data use	Quantitative evaluation
Ecosystem self-sufficiency	More sources for information collection	More products and services may be offered to the customer – expanded target group	Number of business lines in the ecosystem
Ecosystem products integration	Relevance of the information obtained from one service for another service	A higher probability to sell to the customer a complementary product or service	Number of active users making use of more than one service/number of general subscription users (loyalty programs)
Ecosystem customers' satisfaction	Obtaining more detailed customer information	The higher the customer loyalty, the more services may be offered	Evaluation of the application by users

Each factor may have a mixed impact on corporate cash flows. The present research considers the direct influence of various factors on revenue or other proceeds (commission income) as well as the impact on business expenses based on corresponding drivers. The effect from these factors' impact on other general and administrative costs and capital expenditures requires access to more detailed information than that available through regular disclosure by companies.

The key driver of revenue is the number of active users defined on the basis of customer inflow and outflow. Each factor has a positive impact on the driver because it contributes either to an increase in user inflow or decrease in outflow:

1) An increased number of business lines entails an enlarged user inflow as the number of user attraction channels grows for each individual service of the digital business ecosystem.
2) Growing integration of ecosystem products represented by the number of the general subscription users allows to increase the inflow of active users to each individual service of the ecosystem through the existing channels of attracting new users.
3) Customer satisfaction contributes to reducing user churn because the more convenient the service for the customer, the lower the probability of customer churn. High service quality allows to retain active users even when the market offers analog products.

The key driver for business expenses is the need to attract third-party users. The smaller the number of the ecosystem active users or the larger the churn, the more the company has to spend on attracting third-party users: customer inflow from the services integrated in the ecosystem is insufficient to compensate for the churn, so the company has to incur more business expenses in order to maintain the ecosystem's digital products or to develop the application to reduce the churn.

Also, the company has to maintain integration of digital services offering other ecosystem products to active users of a certain business line. However, intersegment revenue/expenses on advertising of various ecosystem business lines within the ecosystem itself may produce a significant effect if it has a higher conversion rate among loyal users. This may be achieved by means of enhancing the efficiency of customer data processing or reducing the cost of attracting one new active customer.

In this paper we consider the impact of certain factors on cash flows, first of all, from the viewpoint of influence of such factors on the inflow and outflow of active users (Table 3).

Table 3. Relationship between Efficiency Factors and Cash Flows

		Ecosystem self-sufficiency	Ecosystem product integration	Customer satisfaction
Income	Revenue growth rate	Positive dependence	Positive dependence	Positive dependence
Expenses	Net cost growth rate	No evident impact	No evident impact	No evident impact
	Business expenses growth rate	Positive dependence	Negative dependence	Negative dependence
	General and administrative cost growth rate	Positive dependence	No evident impact	No evident impact
	Capital expenses / development costs growth rate	Positive dependence	No evident impact	Positive dependence
Impact on cash flows		Mixed impact	Positive impact	Positive impact

On the basis of studied literature as well as qualitative analysis of the influence of the three factors (business ecosystem self-sufficiency, ecosystem product integration and customer satisfaction) expressed in quantitative indicators (number of business lines, number of general subscription users and evaluation of applications by users) on cash flows, we generate the following hypotheses of the present research:

1) Reduction in the number of business lines produces positive impact on ecosystem NPV.
2) Growth in the number of general subscription users exerts a significant positive impact on ecosystem NPV.
3) Increase in ecosystem user satisfaction makes a significant positive impact on ecosystem NPV.

Thus, the hypotheses put forward are as follows.

Hypothesis 1: Reduction in the number of business lines produces a positive impact on ecosystem NPV

It is rather difficult to determine the effect from the increase of the number of business lines in the present research since it requires a higher level of information disclosure by the studied companies or a large number of assumptions. However, it is possible to define the potential effect of a reduction in the number of existing business lines within the financial model by means of judgements and assumptions based on publicly available data disclosed regularly by companies.

Confirmation of the first hypothesis indicates that the ecosystem is completely inefficient. By increasing the number of business lines, the corporate management brings down the value of the business. Such a situation may occur when there are numerous lossmaking services with a negative value and/or a strong negative synergistic effect from im-

plementation and integration of these services. In the first case, the ecosystem has to get rid of unnecessary lossmaking and unpromising projects or give up completely on the ecosystem approach. In the second case, a holding company development strategy is involved: the business comprises completely unrelated business lines. Combination of these strategies will entail an increase in ecosystem value and general business asset value.

Disproval of this hypothesis points to a non-negative effect when implementing the ecosystem approach and confirms a possible positive effect when implementing new services. The non-negative impact of the ecosystem self-sufficiency factor described above is confirmed. If an increase in business value exceeds the value of individual unrelated business lines, we may assert that the ecosystem is efficient and that there exists a positive synergistic effect from implementation of this development strategy.

Hypothesis 2: Growth in the number of general subscription users exerts a significant positive impact on ecosystem NPV

The second hypothesis verifies the degree of the impact of the second factor – ecosystem product integration. The most important factor of ecosystem development is the existence and closeness of the links established between services which allow, within separate segments of the technology industry and interconnection between various industry niches occupied by a certain business ecosystem, to raise the level of service penetration for each individual customer. The greater the number of services used by each particular customer, the higher the loyalty of each particular customer and, consequently, the higher corporate revenue. The element of customer inflow from other business lines into a certain ecosystem unit has a beneficial effect on the growth rate of corporate revenue and cash flow in the future. This raises the ecosystem value.

Hypothesis 3: Increase in satisfaction of the ecosystem users makes a significant positive impact on ecosystem NPV

The third hypothesis verifies the degree of influence of the third factor: ecosystem customer satisfaction. It is assumed that the extent of customer satisfaction shows an inverse dependence on customer churn. The more customers are content with a digital product, the longer they are ready to use it. In order to simplify calculations, the research proposes a linear dependence.

A significant impact in the second and third hypotheses means that when the quantitative parameter (evaluation by users) grows by 1%, the increase in the key performance indicator (ecosystem NPV) is raised by over 1%.

Description of the Research Object: IC PJSC Yandex Ecosystem

The Yandex ecosystem comprises several multidirectional business lines. Each of them comprises a range of different digital services intended to satisfy customer needs in a certain area. For example, a search service, a browser, direct and navigation services are useful to the customer as they provide access to information. Targeted advertising is the main monetization source. It provides the opportunity to advertise services of a specific business line, as well as services representing other business lines.

In the most recent annual statements this business ecosystem disclosed a total of six key business lines: Search & Advertising, RideTech, a combined business line of three different digital e-commerce services, FoodTech and Delivery, Ads Services, Yandex Plus and entertainment services, a combined business line of other technology solutions within the ecosystem.

Similar to most Russian digital business ecosystems, the Yandex ecosystem has the features of a transactional ecosystem (business line services of e-commerce, FoodTech and Delivery, as well as the Ads Services business line) and a solution ecosystem (RideTech and SDG services, Navigation Services and RideTech, the Search Service as well as Devices and Alice etc.).

Over the last year, the share and amount of intersegment revenue have increased significantly. This is indicative of a potentially high integration of services (Figure 2). The intersegment revenue indicator against the background of a digital business ecosystem shows the extent of attention paid in the corporate strategy to the synergy of the services. The more use each business line makes of the user attraction channels or innovative products offered by other business lines, the closer the interrelation between the ecosystem participants and, consequently, the more efficient the information exchange concerning customer needs.

The parameter evaluated in the present research – the number of general subscription users – has also showed a growth tendency over the last year. The ecosystem uses the Yandex Plus subscription to monetize the Yandex Music and Kinopoisk content services. This subscription is also a component of the loyalty program [37] which customers may use to get discounts in other services. This helps to get an additional inflow of active users to these services (Figure 2).

Description of the Research Object: Ecosystem of IC PJSC VK

The IC PJSC VK and IC PJSC Yandex ecosystem comprise several multivarious business lines: social networks and content services, educational technology, business technology and new business lines. When building the business ecosystem, VK management, instead of concentrating on maintaining the operational efficiency of business or growth of service integration, focuses on maximizing revenue by increasing the number of services in each of the four business lines. This is done in an effort to maximize the share in a certain market segment as similar foreign technology solutions withdraw from the country. The company's aggressive investment policy entails not just a significant rise in capital expenses, but also a subsequent increase in operational expenses in order to maintain non-core business lines. Company management spends ecosystem resources unevenly. It does not control or use its main

cash cow – the VK social network – both in terms of the user attraction source and Revenue growth potential.

From the viewpoint of ecosystem classification, applying the abovementioned BCG method, IC PJSC VK combines the features of transactional and solution ecosystems.

If we consider service integration indicators that we used for IC PJSC Yandex, the most apparent difference is the combination with the user satisfaction indicator: the minimum amount of intersegment revenue (Figure 3) combined with a low rating of the main application in app stores (3.8 out of 5 as of 01.05.2024 [38]). On the one hand, the company does not use its key service as a promotion channel for its own products. On the other hand, poor effectiveness of customer information processing may be the reason for the company's insufficiency of investment in development of the core product. A significant factor of the disincentive to develop the core product is the company's almost monopolistic position in the social network market [39].

The indicator of the number of general subscription users is not disclosed in the last annual statements. For this reason, in case of VK one cannot consider the hypothesis of a significant positive impact of this parameter on ecosystem NPV.

Methodology of Building DCF-Models of Business Ecosystems of IC PJSC Yandex and IC PJSC VK

Financial models of both companies have significant limitations related to undisclosed information concerning some segments or entire business lines. For this reason, we have to introduce a range of judgements and assumptions.

The overall scheme of constructing a financial model for business ecosystems is based on the calculation of financial indicators using the main drivers that comprise the average transaction value together with the number of active users of the service. The revenue and business expenses indicator expressed in terms of the cost of attracting one customer and the number of attracted users is calculated separately for each service.

Since there is no data concerning the number of active users of Other Services, it is assumed that the revenue dynamics of general subscription is repeated, out-of-segment expenses duplicate the inflation dynamics, segment expenses are calculated based on the ratio to revenue. Working capital and CAPEX are also calculated on the basis of the historical ratio to Revenue.

In case of VK, the general methodology for calculating financial indicators that comprise the cash flow does not differ significantly from the methodology used for the calculation of Yandex's financial performance. Based on the data regularly disclosed by the company, one may make a forecast using the main drivers for 3 out of 4 business lines: Social Networks and Content Services, Educational Technology and New Business Lines. For the Business Technology business line, the financial performance is calculated proceeding from the premise that the company share in this market segment will grow uniformly up to 5% by the end of the forecast period, with the target market forecast based on data from Statista [40].

The methodology for forecasting the number of active users of each service differs in the two considered financial models. The inflow of users in the Yandex financial model is predicted based on the premises of the active users' inflow via the existing user attraction channels and of the absence of the third-party customers' inflow. In case of VK, apart from the user inflow via the existing channels, third-party users are attracted. They sufficiently compensate for the outflow of current users to keep the total number of active users unchanged. The inflow of "internal" ecosystem users is defined by a determinate sales funnel. It is presumed that each active user of at least one ecosystem service sees contextual advertising of other internal services, 4% of users follow the link, 33.33% complete the registration process, and 80% use at least 1 service. This qualifies as the category of an active user within one forecast period. User churn is predicted for both models identically. The total amount of "leaving" users is calculated on the basis of a determinate indicator of the ratio of the total number of departed users to the total number of users. The latter, in its turn, is defined based on the linear inverse dependence of the rating of this service's application to the highest and lowest value of this indicator (churn rate): 24% and 4% respectively [41]. It is presumed that the cost of attracting a third-party customer is higher for the ecosystem than attracting an internal customer via its own channels.

Research Results

Verification of Hypothesis 1: Reduction in the number of business lines produces a positive impact on ecosystem NPV

Verification of the first hypothesis on the positive impact of a reduction in the number of business lines on ecosystem NPV. It is verified by means of consistent elimination of each business line except for the core one from the ecosystem. After calculating the ratio of an "incomplete" ecosystem consisting of several business lines to the "complete" one, we may calculate the effect of reducing the number of business lines on ecosystem NPV.

As a result of elimination of RideTech and e-commerce business lines, a significant negative impact is revealed. Thus, the NPV indicator takes on negative values – a drop by over 100% – which is explained by the largest share in revenue and the largest number of active users among the complementary business lines (Figure 2). The loss of one of complementary business lines means the loss of one of user attraction channels. This has a negative effect on the rest of business lines and the ecosystem in general. Elimination of the Other Business Initiatives business line produces the least negative effect. The reason is that there is no direct influence of this business line on the active customer flows because it is predicted based on a methodology different from the forecast of other business lines.

Figure 2. The effect of consistently removing each business line from the complete Yandex ecosystem, % of the complete ecosystem

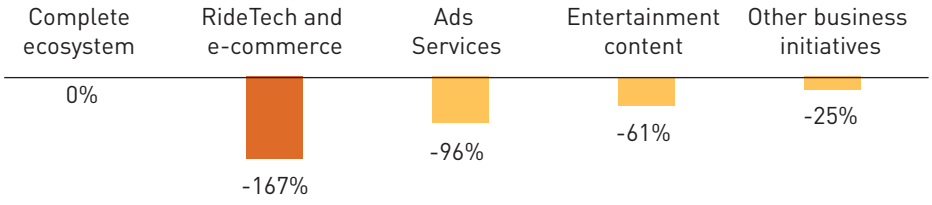


Figure 3. The effect of adding to the main business line in the Yandex ecosystem, in % of the main BL

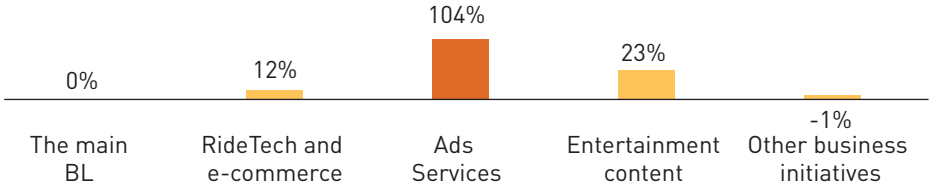


Figure 4. The effect of removing one of the business lines in the VK ecosystem, in % of the NPV of the complete ecosystem

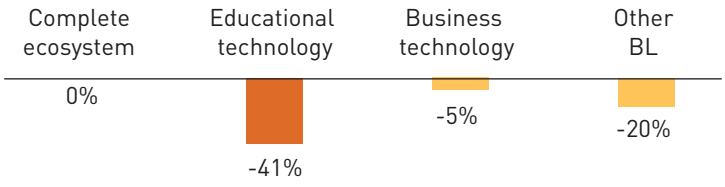
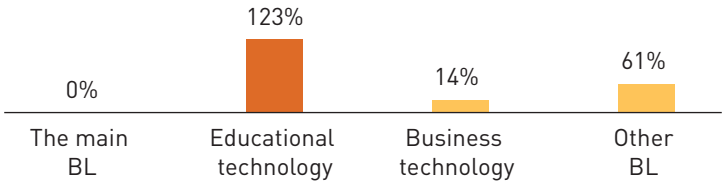


Figure 5. The effect of adding to the main business line in the VK ecosystem, in % of the main BL



Adding one complementary business line to the core business line may have a negative effect due to the growth of working capital in the first forecast period and no compensation of this effect from this business line because at the end of the forecast period positive flows are significantly decreased as a result of the discount factor (Figure 3). Unlike RideTech, the customer base of ads services is not large. Therefore, customer flow from the main business line (Search and Portal) is significantly larger than the outflow in this business line. This exerts a significant positive effect on NPV of the "incomplete" ecosystem.

In case of the VK ecosystem the results of verifying the first hypothesis are similar to the ones obtained after testing this hypothesis for the Yandex ecosystem (Figure 4). Elimination of any complementary business line produces only a negative effect on the ecosystem value. However, the inflow of third-party users mitigates this negative effect.

Similar to the Yandex ecosystem, elimination of a business line calculated on the basis of other suppositions (Business Technology) due to the lack of data on the number of active users has the least negative effect. Consequently, within the financial model such business lines are poorly integrated into the general ecosystem, and their elimination has no impact on the key revenue driver of other business lines – the number of active users (Figure 5).

Unlike in the Yandex ecosystem, the addition any complimentary business line to the core business line has only a positive effect on the incomplete ecosystem indicator. At the same time, the addition of a business line calculated without the key driver also produces the least effect.

Based on the above analysis, we may conclude that the hypothesis regarding the positive impact of a reduction in the number of business lines in the ecosystem is not confirmed. However, when building an incomplete ecosystem that comprises the main business line and one complementary business line, it is possible to obtain a negative effect on ecosystem NPV.

Verification of Hypothesis 2: Growth in the number of the general subscription users exerts a significant positive impact on ecosystem NPV

According to the second hypothesis, the change in the number of the general subscription users (business lines integration parameter) produces a significant positive influence on the ecosystem value.

Due to abovementioned limitation related to available information, the second hypothesis is verified using only the IC PJSC Yandex ecosystem as an example.

Table 4. Calculation of the impact of a change in the number of the general subscription users on the NPV indicator in an "incomplete" IC PJSC Yandex ecosystem, excluding the Other Business Initiatives category (%)

Change in the number of Plus subscribers	-50	-25	-10	0	10	25	50
Change in the ecosystem value	-6.4	-5.8	-2.6	0.0	2.9	7.5	15.6

Table 5. Calculation of the effect of a change in the number of the general subscription users on the NPV indicator of the "complete" IC PJSC Yandex ecosystem (%)

Change in the number of Plus subscribers	-50	-25	-10	0	10	25	50
Change in the ecosystem value	-4.4	-4.4	-2.0	0.0	2.3	5.9	12.3

Table 6. Analysis of Sensitivity to User Satisfaction of the Yandex Ecosystem (%)

Change in the score of the application, % of max.	-3.0	-2.0	-1.0	0.0	1.0	2.0	3.0	5.0
Search and Portal	-7.1	-3.6	-3.6	0.0	0.7	4.3	5.6	4.5
Yandex GO	-10.0	-6.4	-3.7	0.0	3.7	7.4	11.1	4.9
Yandex Market	-6.4	-3.8	-2.0	0.0	2.7	4.9	7.2	4.7
Yandex Lavka	-5.2	-3.7	-1.6	0.0	2.2	4.5	6.7	4.8
Yandex Nedvizhimost	-2.1	-1.3	-0.8	0.0	0.7	1.4	2.1	4.6
Auto.ru	-1.0	-0.6	-0.4	0.0	0.2	0.5	0.8	4.6
Yandex Puteshestviya (travel)	-2.0	-1.3	-0.7	0.0%	0.7	1.3	2.0	4.8
Kinopoisk and Yandex Music	-3.7	-2.7	-1.5	0.0	1.1	2.7	4.2	4.8

If we consider the impact of change in the number of subscribers in an incomplete ecosystem without the Other Business Initiatives business line, we may detect a disproportionate effect when the number of subscribers decreases or increases. In case of an increase, the effect is 2.5 times greater. At the same time, the effect on the NPV indicator is significantly lower than the changed parameter. This contradicts the main hypothesis of a significant impact of this parameter on the key performance indicator (Table 4).

In case of a complete ecosystem, the effect is smaller. However, a disproportionate effect remains when the number of subscribers increases or decreases (Table 5).

Based on the above analysis we may conclude that the hypothesis of a significant impact of the number of the general subscription customers on an ecosystem's NPV is not confirmed. We should also specially mention a disproportionate effect of an increase or decrease of the number of subscribers: the effect of an increase of the number of subscribers is significantly more serious than that of a decrease.

Verification of Hypothesis 3: Increase in satisfaction of ecosystem users has significant positive impact on ecosystem NPV

The third hypothesis of this study suggests a significant impact of customer satisfaction expressed in user evaluation of the company services on ecosystem NPV.

Each of the ecosystem's services belongs to a specific business line. In case of the Yandex ecosystem, satisfaction of the users of Search and Portal services is determined by one score. Each of the other business lines comprises several applications and the effect of a change in satisfaction with each service is calculated separately. To verify this hypothesis, we considered a deviation of users' score by 0.05 points on a scale of 1 to 5 points. Also, this deviation is divided by the users' score and is expressed as a percentage of the customer satisfaction score. For reference, the table on the right shows the users' valuation of the service application.

If we consider the Yandex ecosystem from the point of view of hypotheses, it is important to point out the mixed

impact of satisfaction of a particular service's users on ecosystem NPV. The larger the share of service revenue within the business line and the greater the business line's share in the revenue structure, the more serious the effect of change in user satisfaction (Table 6).

Satisfaction of users of the majority of Yandex ecosystem services exerts a significant impact on ecosystem NPV. This confirms the hypothesis of a significant impact of the user satisfaction factor on the efficiency of ecosystem functioning using the example of the Yandex ecosystem.

In case of the VK ecosystem there is no significant impact of user satisfaction (when the quantitative indicator of the factor changes by 1%, the key performance indicator changes by more than 1%). This may be due to the premise that a loss of users is compensated by an inflow of third-party "non-ecosystem" users. We should also note that a change in the score by the same value will be higher in percentage terms with a lower service score (Table 7).

Table 7. Sensitivity Analysis to User Satisfaction of the VK Ecosystem (%)

Change in the score of the application, % of max.	-3.0	-2.0	-1.0	0.0	1.0	2.0	3.0	5.0
VK social network	-3.3	-2.2	-1.1	0.0	1.0	2.0	2.9	3.8
Odnoklassniki social network	-2.5	-1.5	-0.7	0.0	0.7	1.5	2.3	4.2
Mail service	-0.7	-0.5	-0.3	0.0	0.3	0.7	1.1	4.8
Dzen	-1.8	-1.2	-0.6	0.0	0.6	1.1	1.7	3.9
Skillbox Holding Limited	-1.6	-1.1	-0.5	0.0	0.5	1.1	1.7	3.8
Uchi.ru	-2.6	-1.7	-0.9	0.0	0.9	1.8	2.8	4.4
Mail.ru cloud	-1.3	-0.8	-0.4	0.0	0.4	0.9	1.3	4.6
VK Play	-1.6	-1.1	-0.5	0.0	0.6	1.1	1.7	4.7
RuStore	-1.4	-0.9	-0.5	0.0	0.4	0.9	1.3	3.8

Based on the above analysis we cannot conclude that changes in service user satisfaction produce a definitively significant impact on ecosystem evaluation. In case of the Yandex ecosystem, this hypothesis is confirmed for the majority of services, but this hypothesis is not confirmed for VK. This may be due to an additional inflow of "non-ecosystem" users, which mitigates the negative effect of an increased user churn. In case of the VK ecosystem, the previously mentioned absence of compensation of user churn with the inflow of "ecosystem" users is also relevant. Consequently, the effect of a decrease or increase in customer churn is compensated by increased business expenses.

Conclusion

Based on the research results we may make a conclusion concerning the research hypotheses in relation to the considered Russian ecosystems, namely Yandex and VK:

1) Reduction in the number of business lines produces a positive impact on ecosystem NPV. – Not confirmed for both ecosystems (Yandex and VK).
2) Growth in the number of the general subscription users exerts a significant positive impact on ecosystem NPV. – Not confirmed for the Yandex ecosystem, has not been considered for the VK ecosystem in the present research.
3) Increase in ecosystem user satisfaction makes a significant positive impact on ecosystem NPV. – Confirmed only for the Yandex ecosystem, the impact for the VK ecosystem is insignificant.

On the basis of the verified hypotheses, we may conclude that there is a significant positive impact of such factors as ecosystem self-sufficiency and user satisfaction, and there is an insignificant positive impact of the factor of ecosystem products integration on the key indicator of ecosystem efficiency (NPV).

As a result of comparison of the two companies (IC PJSC Yandex and IC PJSC VK), we may also make the conclusion regarding the key unique characteristics of these ecosystems and their efficiency. Both ecosystems combine the features of solution and transactional ecosystems. By the intersegment revenue indicator, the service integration of Yandex exceeds that of VK. A high satisfaction indicator for the Yandex ecosystem users provides an opportunity to increase the number of active customers without attracting third-party users. Using only the existing channels of active user attraction, the ecosystem acquires more customers than it loses. This is expressed in a more sustainable revenue growth and, consequently, larger cash flows.

Maintaining the customer base by attracting "non-ecosystem" active users from other channels in case of the VK ecosystem allows the company to stabilize revenue. However, in order to increase revenue growth rates ,the company has to improve customer satisfaction which, in its turn, is related to the efficiency of customer data use. VK's weak customer focus is the key factor that influences the increased churn of active users. As a result, the company is deprived of opportunities to obtain more customers within each individual service, business line and the ecosystem as a whole. Low integration of business lines indirectly con-

firms the inefficiency of customer data exchange between business lines. This manifests itself in a low efficiency of investment, which is large with respect to revenue.

Loss of users of the core business line may be compensated by a simultaneous growth in the number of users in other "complementary" services, where an increment of users from the existing channels is significantly higher than the churn. This is observed in the Yandex ecosystem (Figure A1–A5).

In case of the VK ecosystem, the loss of the core line users may not be compensated by the inflow of users to the ecosystem's other business lines from the existing channels . Stabilization of the number of users manifests the ecosystem's inability to grow on the basis of the existing customer attraction channels. This requires compensation from other (third-party) channels of user attraction (Figure A2).

The practical importance of the results of the present research is related to the construction of the most efficient strategy of creation and development of a business ecosystem. The ecosystem approach may be effective if corporate management is capable of building a model of flexible user "flow" from one service to the other. Constructing an ecosystem based on an existing business with a large number of active customers may be more effective than building a range of complementary services from scratch because in this case the company does not need third-party channels to attract users. It is possible to provide user "flow" without losing the total number of "non-unique" users in case of high user satisfaction with the ecosystem services and a high degree of integration of these services. By dvertising an ecosystem service by means of its own sales channels (this function is performed by other ecosystem services), the company may obtain more customer information and, thus, improve user satisfaction. This reduces the churn in the future.

The scientific contribution of our results consists in finding a new line of scientific thought aimed to foster the search for the key factors and evaluation of the degree of their impact on the effectiveness of implementation of the ecosystem approach in business in the context of various industries, regions and countries.

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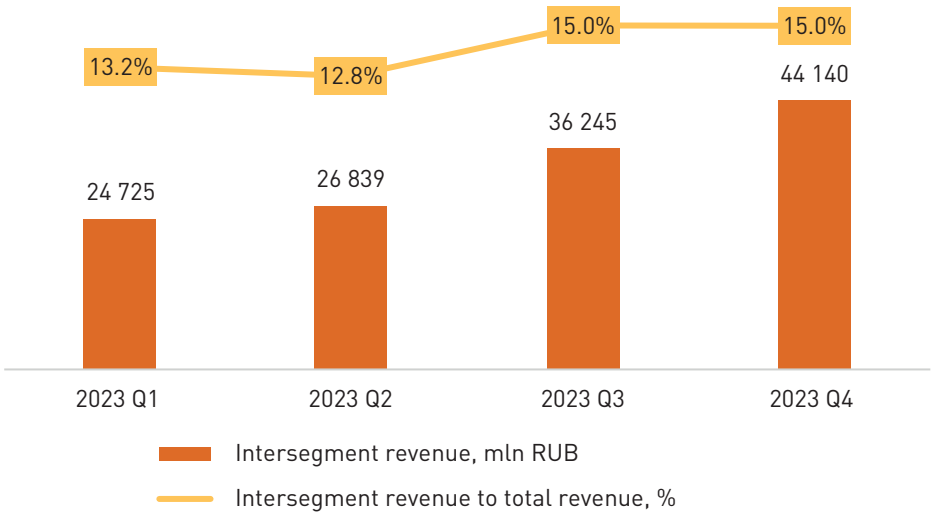
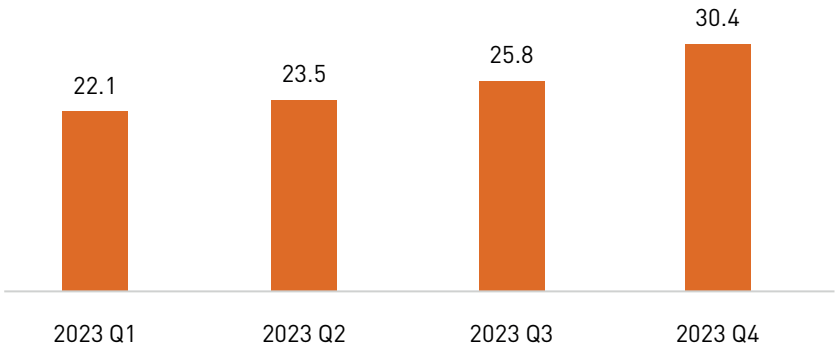
Appendices

Figure A1. Intersegment revenue of the Yandex business ecosystem



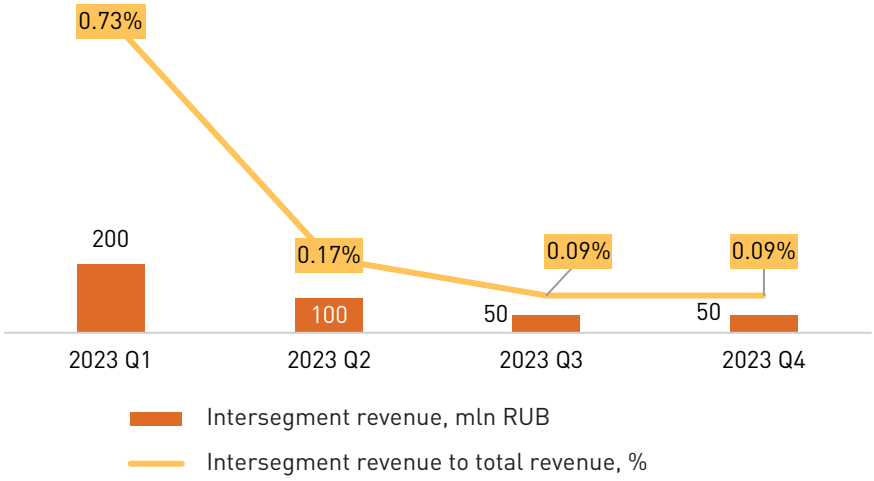
Source: IC PJSC Yandex.

Figure A2. The number of active users of the Yandex Plus service in 2023, mln MAU



Source: IC PJSC Yandex.

Figure A3. Intersegment revenue of the VK business ecosystem



Source: IC PJSC VK.

Figure A4. Total number of users in the business lines of the Yandex ecosystem, mln (non-unique) users

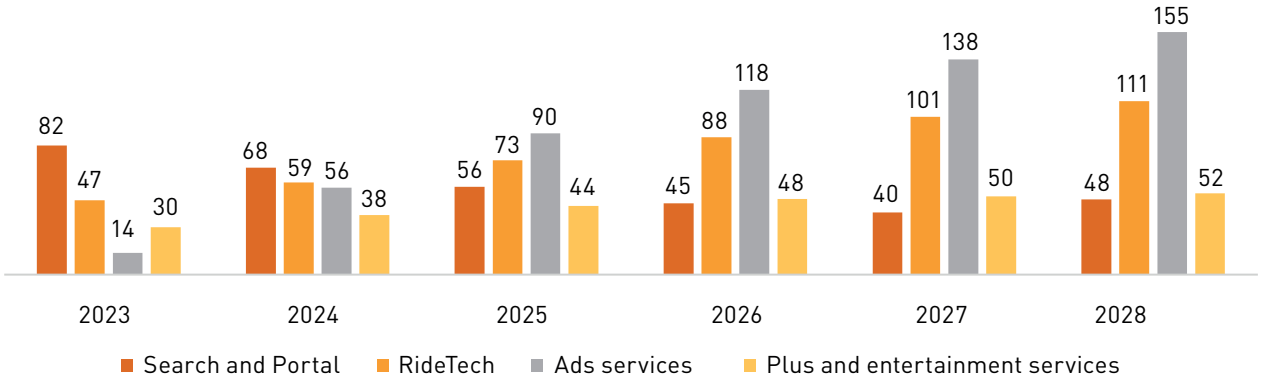
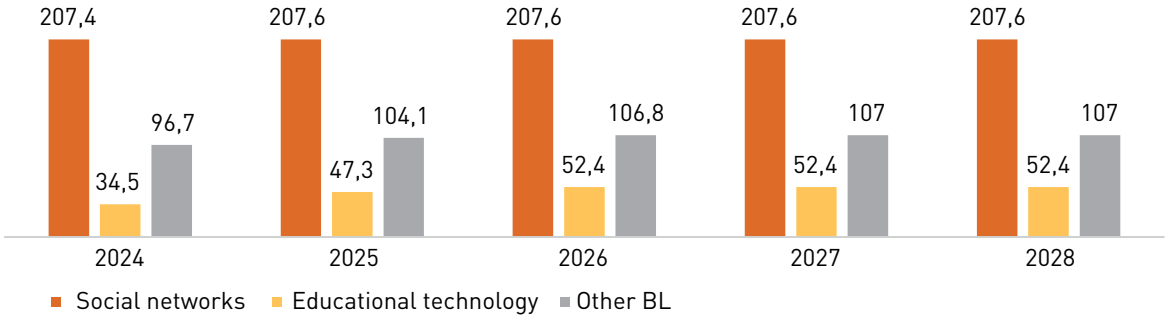


Figure A5. Total number of users in the business lines of the Yandex ecosystem, mln (non-unique) users



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Are Mergers and Acquisitions Boosting Company Performance in the Technology, Media and Telecommunications Sector?

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Abstract

TMT (Technology, Media and Telecommunications) companies account for the largest number of M&A deals worldwide. This stems from their need to constantly evolve due to their high dependence on technological change. Participation in M&As is one of the fastest and most strategically promising ways to accelerate product development, gain access to new technologies, and increase competitive advantage. More than 60% of M&As are unsuccessful and do not contribute to company value creation. Will this conclusion hold for TMT companies, characterized on the one hand by rapid development and high growth rates, and on the other hand by high risks? This paper aims to assess the impact of M&As on the operating performance and value of TMT companies. In contrast to previous literature, it evaluates the M&A performance of TMT companies over the long term by applying an accounting studies logic and an economic profit model. It also contributes to identifying the specific factors that influence the success of TMT M&As. Analyzing a sample of 203 TMT M&As completed between 2003 and 2018, we observe a positive impact on the operating performance (2.2% increase in EBITDA/Sales) and value (+$16.3m in Economic profit) of the combined companies. M&As paid for in stock outperform those paid for in cash, confirming the investment opportunity theory. Domestic M&As are the most efficient due to cultural similarities. We also find a negative impact of the acquirer's R&D intensity on post-M&A performance due to the technology substitution effect. Our findings will be useful to managers and boards for deciding whether to participate in TMT M&As and in understanding the factors that influence the success of these deals.

Keywords: technological deals, operating performance, value creation, economic profit

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Introduction

The TMT sector is of particular interest to investors due to its exceptionally rapid growth, accounting for around 20.86% of global deal values by mid-2024 (Appendix 1). In view of the current uncertainty and the rapid evolution of technologies, TMT companies are striving to capitalize on different innovations, including blockchain, artificial intelligence, cloud technologies and robotic automation processes, integrating them into ecosystems or platforms in order to quickly adapt to changing realities and customer needs. TMT companies must evolve rapidly to maintain a competitive advantage and meet the needs of society. Participation in M&As enables them to accelerate R&D processes and innovation activities, further the acquisition of knowledge and skills, expand their customer base, and develop and implement technologies and innovations [1].

The M&A ambitions of TMT companies tend to be high yet are rarely realized. According to the PWC 2020 M&A Integration Survey[1], only 13% of TMT respondents confirmed that they had achieved their M&A objectives.

The issue of M&A performance is one of the key issues discussed in the current academic literature. However, there is still no consensus among researchers and practitioners on this issue. Companies in developed or emerging markets either experience negative or no gains from acquisitions [2–9] or increase their performance through M&As [10– 13].

Despite the impressive growth trend for acquisitions to be undertaken by companies from the TMT sector, there are no academic empirical papers that examine the performance of such M&As. Most M&A literature tends to focus on the effects of deals, without reference to a specific industry or sector [14; 15]. At the same time, we can observe many studies on the performance of high-tech deals, the results of which also inconsistent [16]. However, we cannot extrapolate results obtained on high-tech samples to the TMT sector as TMT companies focus on a broader spectrum of technologies that enable communications, media and entertainment. In addition, existing studies [17–19] based on high-tech samples typically test the performance of M&As in short-run, based on the event study analysis, suggesting little evidence about the consequence of M&As on firms' operating performance and say nothing about value creation through M&As.

As TMT companies have many specific characteristics that can affect deal performance, investors need to understand the key features of such acquisitions. A separate analysis of the M&As initiated TMT firms is important because these companies, on the one hand, tend to be 'growth companies', with a high proportion of R&D expenses, specializing in new technologies and constantly engaged in a technological competition with other players, but on the other hand, are usually characterized by a higher level of risk due to the complexity of technology integration and information asymmetry regarding the technologies and innovations being acquired, which makes it difficult to correctly assess the target company. By addressing an identified gap in the existing M&A literature, this paper has the potential to contribute to the understanding of the performance of M&As in the TMT sector. We also contribute by identifying the specific factors that influence the success of TMT M&As. Our third contribution relates to the M&A performance measurement in the long run. There are two widely used approaches employed by researchers to measure long-term performance of M&As: accounting studies and long-term window event studies [20]. While examining long-term market reactions to M&As is a popular approach, the former allows the measurement of the post-acquisition performance directly. Nevertheless, the analysis of commonly used book value measures (such as ROE, ROA, EBITDA margins, OCF to market value of assets) of merged companies before and after acquisitions shows us how the operating performance has changed but does not provide information about the impact of M&As on company value. There are only a few studies examining the impact of M&As on corporate value over the long run [3; 21–25]. In this paper, we employ two models – economic profit model and standard accounting model – to assess the performance of M&As in the TMT sector and compare the results.

The study is organized as follows. First, we present literature review and formulate the hypotheses. Next, we describe our methodology and data. Fourth section specifies the data and presents the empirical results, while fifth section sets out the conclusions.

Literature review and Hypotheses

Participating in M&As is one of the most important strategic ways for TMT companies to increase their competitive advantages and realize all possible synergies. One of the key M&A objectives is to improve operating performance. This post-M&A improvement can be effectuated through economies of scale, a more efficient allocation of financial resources, and R&D relocation [26]. In terms of value, experts assert that TMT companies generate more economic profit than any other sector of the global economy[2]. We therefore expect post-M&A benefits and opportunities for TMT companies seeking to keep pace with technological developments to outweigh the risks:

H1. M&As initiated by TMT companies have a positive impact on the operating performance of the combined companies.

H2. M&As initiated by TMT companies have a positive impact on the value of the combined companies.

In addition to testing the M&A performance of TMT firms, we put forward several hypotheses to identify the determinants of such performance, taking into account the

[1] PWC's 2020 M&A Integration Survey. URL: http://sc2la.com/ma-integration-survey.html

[2] Resilience in TMT: Winning in downturns. URL: https://www.mckinsey.com/industries/technology-media-and-telecommunications/our-insights/resilience-in-tmt-winning-in-downturns

features of the TMT sector. We then assess the impact of these determinants on post-M&A operating performance and value.

Method of payment

Managers tend to pay cash (shares) when they believe the stock is undervalued (overvalued). Thus, paying cash may indicate managers' expectations that post-transaction performance will be higher. Free cash flow theory argues that deals paid in cash have higher performance because debt financing reduces agency problem and controls managers' efficiency. In competing bids, a cash offer enables faster deal closures, capturing synergies [7]. On the other hand, when deciding on the payment method, a potential buyer considers other investment opportunities. If a company has a sufficient number of profitable investment projects, it will be more inclined to use shares, which will save cash and avoid increasing debt (Investment Opportunity Theory) [27; 28]. Equity transactions allow a company to diversify risks among shareholders and mitigate the problem of asymmetric information, especially in the case of markets with imperfect information and risky transactions.

M&As initiated by TMT companies are associated with high risks due to the complex integration of technologies and information asymmetry regarding the technologies and innovations being acquired. Payment in shares allows the risk to be shared with the acquirer's shareholders. Therefore, we expect TMT stock-financed M&As to be preferred:

H3. Stock-paid M&As initiated by TMT companies have a positive impact on the performance of the combined companies.

Cross-border vs domestic M&As

Entering new markets is one of the key targets of M&As for TMT companies With increasing globalization, the number of cross-border M&As in all sectors has grown significantly [29]. Participation in such M&As is driven by the desire to increase competitiveness by acquiring new customers and expanding resources [30]. Entering new markets also enhances R&D capabilities [31], which is particularly important for TMT firms. Acquiring foreign firms can generate different tax and exchange rate benefits as well [32]. However, the expected synergies may not be realized due to institutional and cultural characteristics. For the TMT sector, talent retention and cultural alignment are particularly important. Focusing on the acquired assets and talent after the deal helps to improve the performance of the combined companies. However, cultural differences can lead to the complexity of post-M&A management due to a high degree of information asymmetry. As a result, we expect the costs and risks associated with cross-border M&As to outweigh the expected synergy benefits for TMT companies:

H4. Domestic M&As initiated by TMT companies have a positive impact on the performance of the combined companies.

Industry relatedness of M&A participants

More effective integration is also facilitated by a similarity of business models. The greater the similarities between how people involved in the deal work and make money, the higher the likelihood of synergy and value creation. As the TMT sector includes a broad variety of industries, the industry relatedness of M&A participants is important. A diversified M&A can potentially engender high information asymmetry, creating potential agency conflicts for managers and shareholders [33]. Such deals may also lead to problems within the firm [34] and incite department heads to try to obtain rent [35]. Managers also have to study the business processes of another company [1]. All of this can have a negative impact on post-M&A performance.

H5. Focused deals initiated by TMT companies have a positive impact on the performance of the combined companies.

Acquirer's pre-M&A cash reserves

Researchers and practitioners argue that TMT companies usually have sufficient cash reserves that can be used to finance mergers and acquisitions. In a period of rising interest rates, borrowing becomes less profitable. As a result, investors may divert funds away from riskier investment opportunities, making it more difficult to finance M&As. At the same time, it has been argued that the presence of large cash reserves leads companies to engage in value-destroying M&As [36], leading agency costs to increase and M&A performance to decrease [7].

H6. The acquirer's cash reserves before an M&A initiated by TMT companies have a negative impact on the performance of the combined companies.

Acquirer's pre-M&A R&D intensity

For technology companies, R&D investment is a key driver of development [37]. TMT acquirers are typically interested in strengthening their research capabilities [38]. However, high R&D costs are associated with a higher degree of uncertainty [19]. Several studies have emphasized their negative impact on post-M&A performance [39; 40]. Some authors point to a substitution effect, whereby the acquirer's R&D costs negatively affect overall performance [1; 41; 42].

H7. The acquirer's R&D intensity before an M&A initiated by TMT companies has a negative impact on the performance of the combined company.

Acquirer's pre-M&A CAPEX intensity

Capital expenditure is considered a proxy for technological development [10; 19]. CAPEX is used to measure changes in the performance and competitiveness of technology companies upgrading their technological assets [19; 43]. CAPEX intensity also serves as an indirect indicator of innovation activity [44].

H8. The acquirer's CAPEX intensity before an M&A initiated by TMT companies has a positive impact on the performance of the combined company.

Methodology

This section details the methodology used in this study. First, we present the methodology of accounting studies. Then we explain the concept of economic profit. Lastly, we present our regression analysis on cross-sectional data, including the description of dependent, independent and control variables.

Operating performance: change and intercept models

In the first step, we apply the change model based on previous research [2; 10; 24; 37]. The essence of this model is to compare the medians of operating performance measures before and after the deal. The TMT sector includes a broad range of industries. Therefore, we make industry adjustments [2–4; 10; 45] based on the industry median benchmark. The Wilcoxon signed rank test is used to verify the significance of the results obtained. We use *EBITDA/Sales*, *(EBITDA-ΔWC)/Sales* and *EBITDA/Total assets* to measure operating performance. For *EBITDA/Total Assets* we consider the book value of assets [4]. We use these expressions insofar as cash-flow-based measures of operating performance are preferable.

We analyze the following time window: three years before and three years after the deal is closed [–3; +3]. Acquirers need several years to fully integrate targets. A three-year period increases the likelihood that post-M&A returns and synergies will be reflected in the combined company's financials [46]. Similarly, McKinsey and PWC experts assert that, for TMT M&As, it is necessary to analyze the impact at least two years after the deal[3]. Existing research also suggests that potential synergies, if any, are realized within three years of the deal.

The intercept model is used to check the robustness of the results [2–4; 10; 24; 45].

We use the following regression:

$$Median\ performance\ indicator_{post,i} = \\ = \alpha + \beta \times Median\ performance\ indicator_{pre,i} + \varepsilon_i, \quad (1)$$

where $Median\ performance\ indicator_{post/pre,i}$ is the median of the post/pre-deal performance measure (pre-deal includes both acquirer and target results).

The intercept (α) reflects the impact of M&As. For the M&A to have an impact, α must be greater than zero. The slope (β) indicates the relationship between the pre- and post-deal performance measures.

Value-based performance: economic profit

In the second step, we assess the impact of M&As on the *Economic profit* (*EP*) measure. In line with previous research, we calculate the combined *Economic profit* (*EP*) before the deal as follows:

$$EP_{combined,t} = EP_{target,t} + EP_{acquirer,t}, \quad (2)$$

where $EP_{(acquirers/target,t)}$ is the target's/acquirer's *EP* during period *t*;

$$EP_{acquirer/target,t} = CE_{t-1} \times (ROCE_t - WACC_t), \quad (3)$$

where CE_{t-1} is the target's/acquirer's *Capital Employed* during period *t-1*;

$ROCE_t$ is the target's/acquirer's *Return on Capital Employed* during period *t*;

$WACC_t$ is the target's/acquirer's *Weighted Average Cost of Capital* during period *t* [3; 24].

We also adjust this indicator for the industry to exclude industry trends:

$$EP_{i,t}^{ind} = EP_{i,t} - \left(\frac{Industry\ EP_t}{Industry\ CE_{t-1}}\right) \times CE_{i,t-1}, \quad (4)$$

where $EP_{i,t}$ is the acquirer's/target's *EP* during period *t*;

$CE_{i,t-1}$ is the acquirer's/target's *Capital Employed* during period *t-1*;

$Industry\ EP_t$ is the industry average *Economic profit* during period *t*;

$$\frac{Industry\ EP_t}{Industry\ CE_{t-1}}$$

is the industry average economic profit per dollar of capital in a specific industry during period *t*;

$$\left(\frac{Industry\ EP_t}{Industry\ CE_{t-1}}\right) \times CE_{i,t-1}$$

is the industry average *EP* for a company of the same size during period *t-1* [3].

Cross-sectional regression analysis of post-M&A performance

In the last step, we apply a multivariate OLS regression to cross-sectional data to assess the impact of the identified determinants on post-M&A performance:

$$Median\ (Performance\ indicator)_{i,t}^{after} = \\ = \alpha + \beta_1 \times Median\left(Performance\ indicator\right)_{combined\ i,t}^{before} + \\ + \beta_2 \times MOP_i + \beta_3 \times DealNature_i + \beta_4 \times INDR_i + \\ + \beta_5 \times RDIntA_i + \beta_6 \times CashResA_i + \beta_7 \times CountryA_i + \\ + \beta_8 \times Relative\ sizeT_i + \beta_9 \times LevA_i + \varepsilon_i, \quad (5)$$

where $Median\left(Performance\ indicator\right)_{combined\ i,t}^{before}$

is the combined performance indicator of deal participants during period *t*;

MOP_i is the method of payment (1 – if the M&A deal was paid in stock, 0 – if the M&As was paid in cash or (cash + stock));

$DealNature_i$ is the nature of the deal (1 – if the deal is cross-border, 0 – if the deal is domestic);

[3] How can TMT companies supercharge go-to-market payoff from acquisitions? URL: https://www.pwc.com/us/en/industries/tmt/library/ma-integration.html

$INDR_i$ is the industry relatedness of the deal participants (1 – if acquirer and target belong to the sameindustry in TMT sector, 0 – if acquirer and target belong to different ~~macro~~ industries);

$RDIntA_i$ is the acquirer's R&D intensity (*R&D expenditures/Sales A* one year before the M&A [19];

$CashResA_i$ is the acquirer's cash reserves ((*Cash and cash equivalents A*)/*Total assets A* one year before deal completion [47]);

$CountryA_i$ is the nature of the acquirer's country of incorporation (1 – if the acquirer's country of incorporation is developed, 0 – if the acquirer's country of incorporation is emerging);

$Relative\,sizeT_i$ is the target's relative size (Ln (*Total assets T/Total assets A*));

$LevA_i$ is the acquirer's leverage (*Total debt A/Total asset A* one year before the M&A [46; 47]).

Data

We collected M&A data from the Thomson Reuters Eikon dataset, covering the period from January 2003 to December 2018 (global markets). This period is explained by the fact that we analyzed the companies 3 years before and 3 years after the deal. The period 2003–2018 for M&As and 2000–2021 for financials is the widest and most accessible. We applied the following criteria:

- Only completed M&As;
- Deal value: at least USD 10 million;
- Only public acquirers and targets;
- Serial deals excluded;
- Acquired stake:
  ≥ 50% +1 share [4; 10; 24; 47];
- Available financial data for both the acquirer and the target.

We obtained 203 M&As for a total amount of USD 142 898.9 million. Such a sample size is typical for this type of study due to the unavailability of pre-deal financial data for the target company [4; 10; 24; 47]. For the financial data needed to calculate the *Economic profit* (*EP*), we used the Bloomberg database.

The distribution of TMT acquirers by industry is shown in Table 1.

Table 1. Distribution of TMT acquirers by industry

	Number of deals	Percentage in TMT, %	Deal value (USD million)
Technology group			
Computers & Peripherals	22	10.84	7 037.5
E-commerce / B2B	3	1.48	553.04
Electronics	10	4.93	4647.25
Internet Software & Services	12	5.91	8405.69
IT Consulting & Services	29	14.29	9799.29
Semiconductors	36	17.73	23 294.84
Software	40	19.70	6665.06
Other high technology	1	4.92	541.82
Total	153	75.37	62 944.49
Media group			
Broadcasting	11	5.42	5166.5
Cable	7	3.45	24 623.5
Advertising & Marketing	2	0.99	1607
Total	20	9.85	31 397
Telecommunications			
Telecommunications Equipment	10	4.93	7631.8
Telecommunications Services	11	5.42	32 736.3
Space and Satellites	1	0.49	731
Wireless	7	3.45	7271.4
Other telecom	1	4.92%	186.9
Total	30	14.78	48 557.4
Number of deals with acquirers from TMT	**203**		**142 898.9**

Most acquirers in our sample belong to the Technology group (153, or 75.37%). We excluded many serial deals with media companies. As a result, the number of M&As involving acquirers from the Media group was only 20, or 9.85%. The number of M&As involving acquirers from the Telecommunications group was 30, or 14.78%.

Table 2 shows the distribution of acquirers by country.

Table 2. Sample description: distribution by the acquirer's country of incorporation

Country	Number of deals	Percentage in total sample, %	Deal value (USD million)	Percentage in total value, %
Argentina	1	0.49	–	–
Australia	8	3.94	2 514.6	1.76
Austria	1	0.49	29.6	0.02
Brazil	3	1.48	5 972.4	4.18
Canada	8	3.94	3 942	2.76%
China (Mainland)	4	1.97	3 674.9	2.57
France	5	2.46	7 572.8	5.30
Germany	6	2.96	263	0.18
Hong Kong	4	1.97	25 697.4	17.98
India	2	0.99	1 035.4	0.72
Indonesia	1	0.49	1 155.6	0.81
Israel	3	1.48	521.3	0.36
Japan	17	8.37	5 659.6	3.96
Kazakhstan	1	0.49	445.9	0.31
Luxembourg	1	0.49	731	0.51
Malaysia	1	0.49	26	0.02
Netherlands	1	0.49	754.5	0.53
Norway	1	0.49	63.1	0.04
Poland	1	0.49	20.9	0.01
Singapore	2	0.99	1 483.6	1.04
South Africa	1	0.49	248.7	0.17
South Korea	7	3.45	5 379.6	3.76
Spain	1	0.49	337.9	0.24
Sweden	4	1.97	126.4	0.09
Switzerland	2	0.99	378.2	0.26
Taiwan	14	6.90	4116.9	2.88
Thailand	2	0.99	1 451.4	1.02
United Kingdom	15	7.39	9 634.1	6.74
United States	86	42.36	60 108.1	42.06
Total	**203**	**100**	**142 898.9**	**100**

In our sample, the greatest number of acquirers in M&As came from the United States (86, or 42.36%). In comparison, relatively few M&As were initiated by Japanese acquirers (17, or 8.37%). The United States was also the largest player in terms of value (USD 60 108.1 million).

Empirical Results

In this section we examine the impact of M&As on the performance of TMT companies. First, we represent the impact of a TMT M&A on the operating performance of the combined company. Next, we assess the changes in the post-M&A value of the company, as measured by the economic profit indicator. Finally, we test the identified determinants of post-M&A performance.

Post-M&A operating performance and company value

Analyzing the raw operating performance indicators, we find positive changes in the medians of *EBITDA/Sales* (+1.91%), (*EBITDA-ΔWC*)*/Sales* (+2.05%) and *EBITDA/Total assets* (+0.8%) three years after deal completion. As we assume that these changes may be related to industry trends, we proceed to analyze industry-adjusted measures.

Appendix 3 shows the results of the changes in the industry-adjusted post-M&A operating performance of TMT companies and their value as measured by the economic profit indicator.

We found statistically significant improvements in the median of operating performance measures: +1.93 and +2.20% for *EBITDA/Sales* and +1.59 and +2.02% for (*EBITDA-ΔWC*)*/Sales* two and three years after the deal, respectively, and +0.80% for *EBITDA/Total assets* three years after the deal. A robustness check performed using an *intercept model* showed positive changes in the *EBITDA/Sales* indicator three years after the deal. We can therefore conclude that changes in cash-flow-based operating indicators are not driven by industry trends, confirming the positive impact of TMT-initiated M&As on the performance of the combined companies. On average, TMT acquirers are able to realize planned synergies from M&As. This result supports our initial arguments, showing that participation in M&As is one of the best ways for TMT companies to achieve cost synergies. This result is in line with Lok et al. [18], who find an improvement in post-M&A operating performance for high-tech firms (+0.86%), yet inconsistent with Lys and Vincent [17].

In terms of value, we see negative median values for the *Economic profit* (*EP*) indicator before M&As. This shows that not all companies in our sample are effective in terms of value. However, most of them are able to generate a profit based on their operating activities. At the same time, the economic profit is positive for 63.86% of the TMT companies in our sample three years after the deal. Based on industry-adjusted results, we find a positive difference in *Economic profit* (*EP*) for our sample (+$16.3 million). This supports our findings based on the examination of changes in the selected operating performance indicators in the previous step of our analysis. The results obtained are inconsistent with most existing studies [3; 21; 22; 24; 25; 48]. This can be explained by the lack of similar studies at the sector and industry levels. There are no studies in the literature which examine the impact of M&As on the value of the combined companies, as measured by the *Economic profit* (*EP*) indicator, for a sample of M&As involving technology companies. Our results support our first and second hypotheses.

Next, we divided our sample into subsamples according to the factors set forth in the hypotheses.

Method of payment

We observe statistically significant positive changes in the industry-adjusted medians of the *EBITDA/Sales* (+1.57%), *EBITDA/Total assets* (+0.74%) and *Economic profit* (+USD 38.5 million) three years after stock-paid M&As (Appendix 4).

Our results are consistent with the argument that paying in stock allows the acquirer's shareholders to share the risk, supporting our hypothesis about the positive impact of M&As paid in stock on the performance of the combined companies. This is in line with the "Theory of Investment Opportunities" and the findings of Grigorieva and Petrunina [24] yet inconsistent with Martynova et al. [4]. Thus, we confirm our third hypothesis.

Cross-border vs domestic M&As

Our results show statistically significant positive changes in the industry-adjusted median of the *EBITDA/Sales* (+2.33%), *EBITDA/Total assets* (+0.93%) and the *Economic profit* (+USD 17.8 million) of domestic M&As initiated by TMT companies (Appendix 5).

We confirm our fourth hypothesis that domestic M&As for TMT companies have a positive impact on the performance of the combined companies. Our results are consistent with Moeller *et al.* [49; 50], Gomes *et al.* [51], and Grigorieva and Petrunina [24] yet inconsistent with Kang [32]. The costs and risks associated with cross-border M&As for TMT acquirers exceed the benefits from synergies.

Determinants of post-M&A performance

In the third step of our analysis, we identify the determinants of post-M&A performance for combined companies. We construct multivariate regressions for all selected operating performance indicators for the periods [−1; +1], [−2; +2], and [−3; +3] (Table 3).

Table 3. Determinants of post-M&A operating performance (industry-adjusted)

	EBITDA/Sales			(EBITDA-ΔWC)/Sales			EBITDA/Total assets		
	(3)	(2)	(1)	(3)	(2)	(1)	(3)	(2)	(1)
Slope	0.195***	0.065***	0.028***	0.226***	–0.135*	–0.059***	0.368***	0.298***	0.14*
	(0.066)	(0.022)	(0.008)	(0.057)	(0.069)	(0.021)	(0.104)	(0.096)	(0.084)
MOP	0.061**	0.097***	0.097**	0.116***	0.099**	0.045	0.031**	0.042**	0.07**
	(0.026)	(0.032)	(0.048)	(0.041)	(0.040)	(0.058)	(0.014)	(0.019)	(0.029)
Country	0.029	0.001	–0.014	0.006	–0.092	–0.139*	0.01	-0.009	-0.011
	(0.066)	(0.078)	(0.062)	(0.100)	(0.098)	(0.081)	(0.048)	(0.044)	(0.044)
DealNature	–0.049	–0.049	–0.029	–0.101**	–0.048	–0.01	-0.029	-0.033	-0.029
	(0.033)	(0.035)	(0.048)	(0.044)	(0.044)	(0.078)	(0.018)	(0.020)	(0.027)
INDRel	0.107***	0.137***	0.122**	0.122**	0.134**	0.066	0.039*	0.052*	0.043
	(0.034)	(0.039)	(0.059)	(0.051)	(0.055)	(0.070)	(0.021)	(0.029)	(0.044)
LevA	–0.12	–0.12	–0.215	–0.086	–0.03	–0.009	-0.077	-0.03	-0.097
	(0.112)	(0.109)	(0.193)	(0.139)	(0.157)	(0.238)	(0.056)	(0.077)	(0.113)
CashResA	0.018	–0.033	–0.075	–0.016	–0.1	–0.129	-0.008	-0.045	-0.075
	(0.081)	(0.102)	(0.125)	(0.130)	(0.150)	(0.219)	(0.056)	(0.090)	(0.077)
RelSizeT	–0.006	–0.001	0.005	–0.008	–0.006	–0.013	0.002	0.002	0.005
	(0.004)	(0.009)	(0.005)	(0.012)	(0.008)	(0.009)	(0.002)	(0.002)	(0.004)
R&DintA	–0.251	–0.36***	–0.46***	–0.082	–0.867**	–0.62**	-0.12**	-0.075	-0.167**
	(0.199)	(0.111)	(0.102)	(0.187)	(0.374)	(0.279)	(0.047)	(0.057)	(0.066)
CAPEXIntA	0.376***	0.457***	0.631***	0.369*	0.26	0.199	0.12	0.126	0.228**
	(0.140)	(0.173)	(0.202)	(0.221)	(0.208)	(0.263)	(0.084)	(0.086)	(0.114)
Constant	–0.09	–0.102	–0.079	–0.112	0.041	0.116	-0.026	-0.035	-0.034
	(0.077)	(0.090)	(0.113)	(0.116)	(0.128)	(0.140)	(0.058)	(0.062)	(0.079)
R^2	0.598	0.454	0.296	0.463	0.372	0.187	0.481	0.328	0.194
F-statistics	13.356***	8.747***	18.884***	8.951***	3.892***	3.940***	7.236***	5.592***	5.029***
VIF	1.42	1.392	1.313	1.300	1.375	1.299	1.320	1.337	1.324

*** P<0.01, ** P<0.05, * P<0.1(Wilcoxon signed rank test is used).

Source: authors' calculations

From Table 3, we see that 8 out of 9 regressions demonstrate a positive and statistically significant impact of payment method on post-M&A performance. We have already demonstrated this for M&As paid by stock, and so the results are in line both with our initial hypothesis and with our findings in the previous two steps of the analysis.

In 7 out of 9 models, we find a positive and statistically significant impact of industry relatedness on post-M&A performance. These results support our initial arguments about the effectiveness of M&As involving participants with similar business models. Such M&As facilitate the process of integration and the realization of future synergies and value. Our results are consistent with Yook [3], Grigorieva and Petrunina [24] and Lim and Lee [52], yet inconsistent with Ghosh [2], Powell and Stark [11] and Martynova et al. [4].

In 6 out of 9 models, we see a statistically significant negative impact of the acquirer's R&D intensity on the performance of the combined company. These results support our initial argument that high R&D expenditures are associated with a higher degree of uncertainty and that the substitution effect leads to a negative influence of the acquirer's R&D costs on overall performance. Thus, for a company that actively implements R&D on its own, it is more difficult to integrate and use the target company's technologies, while acquired knowledge can potentially substitute for existing knowledge. These results are consistent with Hitt et al. [1], Blonigen and Taylor [41], Cassiman et al. [42], Dranev and Ochirova [19], and inconsistent with Chan et al. [39] and Lin and Lee [40].

In 5 out of 9 models, we see a positive statistically significant influence of the acquirer's CAPEX intensity on the performance of the combined company. Our results are consistent with our initial arguments and previous studies that identified CAPEX as an indirect indicator of technological development [10; 19]. We did not find any statistically significant impact of the control variables on performance during the post-M&A period. Thus, our initial arguments that companies with a high proportion of debt are usually controlled by financial institutions and insured against unprofitable M&As are not supported by our sample. These results are in line with [42; 45].

The relative size of the target also has no impact on the performance of the combined companies. This can be explained by the specifics of M&As with TMT companies and their pre-deal strategic plans. TMT companies have different integration processes than other sectors. The initiation of M&As is meticulously planned by TMT acquirers. The focus on success leads to a careful selection of the target company, whose size would guarantee a win-out in any case. These results contradict Alexandridis et al. [53] and Lok et al. [18], who find a negative impact of the relative target size on post-M&A performance.

Conclusion

The high level of activity in the TMT sector is driven by the rapid development of digital technologies and innovation, inciting companies to maintain their competitive advantage and increase their influence and relevance in global markets. Investor interest in TMT transactions remains strong, as widespread digitalization, the shift to remote work, new technologies, digital transformation, cloud computing, and data-driven capabilities constitute an integral part of successful company growth strategies.

In this study, we analyzed the impact of M&As initiated by TMT companies on their operating performance and value, as well as identifying the determinants of post-M&A performance. Based on a sample of 203 M&As initiated by TMT companies and completed between 2003 and 2018, we found a positive impact of TMT M&As on the operating performance of the combined companies. Industry-adjusted results showed statistically significant improvements in the median values of *EBITDA/Sales* (+2.20) and *EBITDA/Total assets* (+0.80). We found robust results for *EBITDA/Sales*, which increased by 2.20% using the *change model* and by 3.1% using the *intercept model* three years after the deal. We therefore concluded that TMT-initiated M&As have a positive impact on the operating performance of the combined companies. On average, TMT acquirers are able to realize planned synergies from M&As.

We found that M&As initiated by TMT companies paid by stock have a positive impact on the performance of the combined companies. Our results are in line with our initial argument that paying in stock allows acquirers to share risks with their shareholders. We also proved that the costs and risks associated with cross-border M&As for TMT acquirers exceed the benefits from synergies. We found similar results based on an examination of changes in the company value measured by the *Economic profit* (*EP*) indicator. We discovered a positive statistically significant change in the median *Economic profit* (*EP*) indicator for the domestic subsample (+USD 17.8 million) and companies involved in M&As paid by stock (+USD 38.5 million).

In the final part of our analysis, we examined the influence of the identified determinants on post-M&A performance and found similar results, confirming our initial findings. We also showed a statistically significant impact of the industry relatedness (+), the acquirer's R&D intensity before the deal (–), and the acquirer's CAPEX intensity before the deal (+) on the performance of the combined company.

Our research has practical implications for managers of TMT companies, motivating them to participate in M&As to achieve operational synergies with economies of scale and a more efficient allocation of financial resources. In addition, our results suggest that companies with higher R&D expenditures may experience lower M&A returns due to difficulties in integration processes and the use of the target's technologies. Our findings can also be used by investors and shareholders for forecasting the future performance of TMT companies.

One of the limitations of this study is its use of industry adjustments based on the industry median benchmark but not on the median values of comparable companies' indicators. Our sample also includes a limited number of companies with suitable financial data for the Economic profit (EP) calculation.

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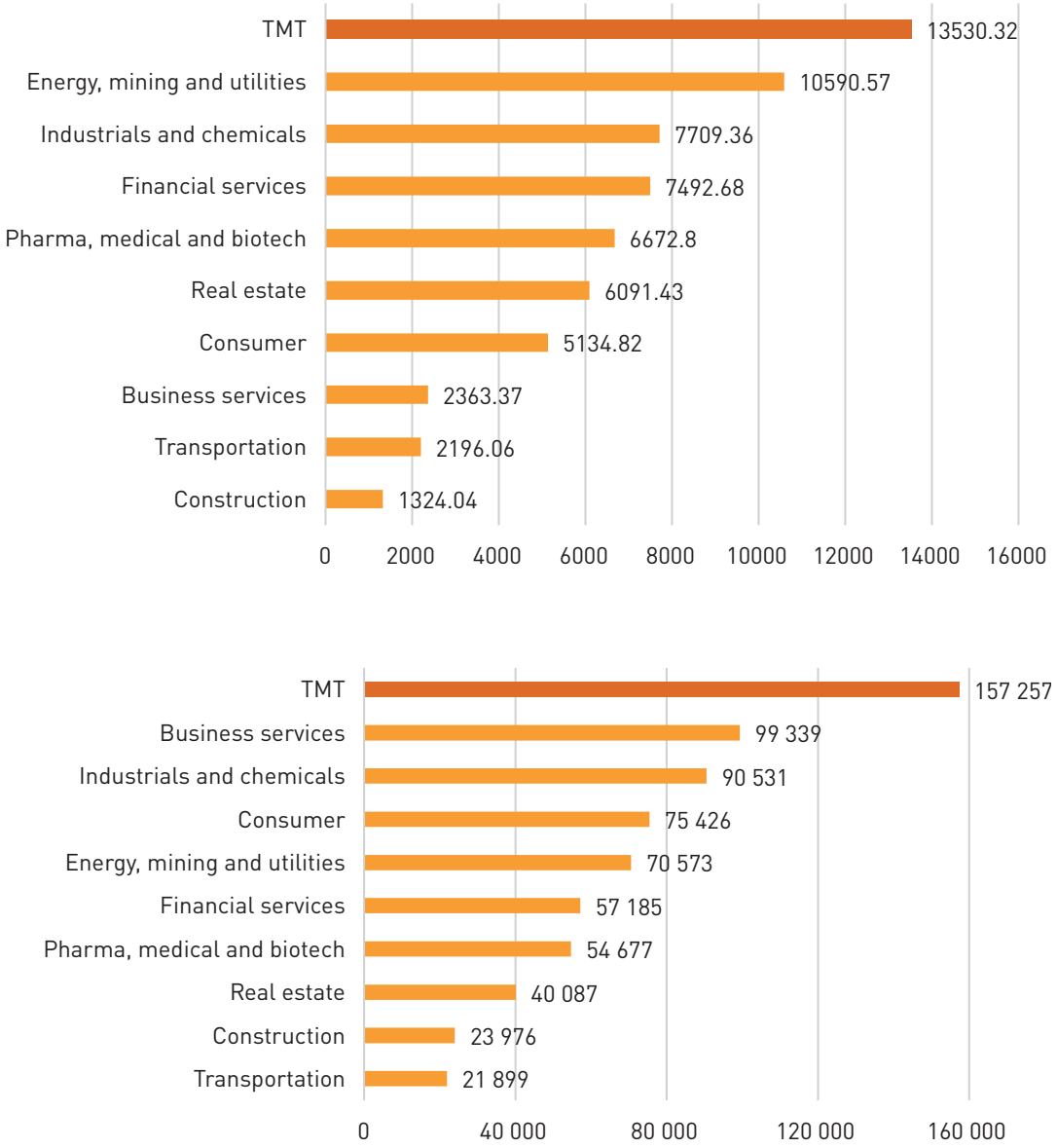
Appendixes

Appendix 1. Place of TMT M&As on the global stage



Source: Data presented by White & Case. URL: https://mergers.whitecase.com/#!

Appendix 2. Value-based performance measures of post-M&A results

Author	Period and country, sector or industry	Sample	Performance indicator	Adjustments	Results
Sirower & O'Byrne (1998) [21]	1979–1990, US	41 M&As	Economic Value Added (EVA)	Pre-M&A performance	Deterioration
Yook (2004) [3]	1989–1993, US	75 largest M&As	Economic Value Added (EVA)	IMP	Deterioration
Guest et al. (2010) [22]	1985–1996, UK	303 M&As	ROE, Residual Income Value (RIV)	IMP, size	Enhancement (ROE), no significant results (RIV)
Singh et al. (2012) [48]	2005–2008, India	17 M&As	Economic Value Added (EVA), ROCE, EPS	-	Deterioration
Kan & Ohno (2012) [54]	1989–2008, largest banks in Japan	13 M&As	Economic Value Added (EVA)	Pre-M&A performance	Not all M&As contributed to the increase in EVA
Leepsa & Mishra (2013) [23]	2003–2004; 2006–2007, Manufacturing sector in India	29 M&As	Economic Value Added (EVA)	Industry average, size	No significant results
Grigorieva & Petrunina (2015) [24]	2002–2009, Emerging capital market	80 M&As	EBITDA/BVA, EBITDA/Sales, (EBITDA-ΔWC)/BVA, (EBITDA-ΔWC)/Sales, Economic profit (EP)	IMP	Deterioration in EBITDA/Sales and Economic profit (EP)
Hassan & Giouvris (2020) [25]	1992–2018, financial institutions	1485 mergers	ROE, ROIC, Economic Value Added (EVA)	Pre-M&A performance	Improvement in ROE and ROIC; deterioration in EVA

Source: created by the authors.

Appendix 3. Impact of TMT-initiated M&As on the combined company's operating performance measured by EBITDA/Sales, (EBITDA-ΔWC)/Sales, EBITDA/Total assets, (EBITDA-ΔWC)/Total assets, and value measured by Economic profit (EP)

	EBITDA/ Sales	(EBITDA-ΔWC)/ Sales	EBITDA/ Total assets	(EBITDA-ΔWC)/ Total assets
Industry-adjusted medians				
Median post-M&A performance (-3; +3)	2.46%	–0.96%	0.54%	–2.12%
Differences – industry-adjusted medians				
[–3;+3]	2.20%***	2.02%***	0.80%**	0.76%
[–2;+2]	1.93%***	1.59%*	1.12%	0.52%
[–1;+1]	1.07%	–0.87%	0.23%	–1.05%

	Economic profit – RAW			Economic profit – ADJ		
Median post-M&A performance (–3; +3)			-3.3			–2.9
	Change	Z-score	N	Change	Z-score	N
[–3;+3]	15.3**	2.316	85	16.3***	2.592	83
[–2;+2]	5.4	1.431	85	6.5	1.505	82
[–1;+1]	3.6	1.109	70	3.6	1.057	68

*** P<0.01, ** P<0.05, * P<0.1(Wilcoxon signed rank test is used).
*Economic profit values are in USD million.

Source: authors' calculations.

Appendix 4. Impact of TMT-initiated M&As on the combined company's operating performance measured by EBITDA/Sales, (EBITDA-ΔWC)/Sales, EBITDA/Total assets, (EBITDA-ΔWC)/Total assets, and value measured by Economic profit (EP) based on the method of payment (cash, stock and mix)

	EBITDA/Sales			EBITDA/Total assets		
	Cash	Stock	Mix	Cash	Stock	Mix
	Differences between pre- and post-M&A performance					
[−3; +3]	0.67%	1.57%*	5.71%***	0.76%	0.74%*	2.04%
[−2; +2]	0.64%	1.55%**	4.50%	0.97%	1.36%	1.68%
[−1; +1]	1.10%	1.07%	0.98%	0.36%	0.27%	-0.80%
Economic profit	Cash		Stock		Mix	
Median pre-M&A performance	−16.9		−32.7		−8.1	
Median post-M&A performance	−5		−4.4		3.3	
Change						
[−3;+3]	5.2		38.5**		9.7	
[−2;+2]	−0.9		36.7**		2.3	
[−1;+1]	0.4		9.1		1.3	

*** P<0.01, ** P<0.05, * P<0.1(Wilcoxon signed rank test is used).

*Economic profit values are in USD million.

Source: authors' calculations.

Appendix 5. Impact of TMT-initiated M&As on the combined company's operating performance measured by EBITDA/Sales, (EBITDA-ΔWC)/Sales, EBITDA/Total assets, (EBITDA-ΔWC)/Total assets, and value measured by Economic profit (EP) based on the nature of the deal (cross-border vs domestic)

	EBITDA/Sales		EBITDA/Total assets	
	Cross-border	Domestic	Cross-border	Domestic
	Differences between pre- and post-M&A performance			
[−3;+3]	−0.12%	2.33%***	0.71%	0.93%**
[−2;+2]	−0.54%	2.48%***	−1.52%	1.57%**
[−1;+1]	0.67%	1.14%*	−0.49%	0.41%
Economic Profit				
	Domestic		**Cross-border**	
Median post-M&A performance	−14,0		−25,5	
Median post-M&A performance	2.5		−27.5	
Change				
[−3;+3]	17.8***		−1.5	
[−2;+2]	12.2**		−9.6	
[−1;+1]	7.1		−14.2	

*** P<0.01, ** P<0.05, * P<0.1(Wilcoxon signed rank test is used).

*Economic profit values are in USD million.

Source: authors' calculations.

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Disclosing Current Insights: A Bibliometric Analysis of CSR and Corporate Performance Trends

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Abstract

In this paper we conduct a systematic bibliometric analysis to explore the correlation between corporate social responsibility (CSR) and corporate performance. Despite extensive research on CSR's financial impact, this study aims to offer fresh insights by systematically examining trends and origins in the literature from 2012 to 2022. Additionally, by integrating theoretical foundations with bibliometric analysis, our study addresses a critical gap in the literature, advancing an understanding of CSR's role in shaping sustainable business practices. Through the analysis of 283 articles using PRISMA, we observe a significant rise in publications on CSR's impact, especially in Chinese and American contexts, which highlight themes like sustainable development and CSR reporting. By comparing these findings to existing literature, our study contributes to understanding CSR's evolution. We emphasize the importance of future research that explores these interactions, particularly in African countries, to comprehend CSR's development in diverse contexts. In conclusion, our research provides original insights into the evolving relationship between CSR practices and corporate performance, guiding future scholarly exploration. This study's novelty lies in its comprehensive analysis of recent literature, revealing emerging themes and connections in CSR and corporate performance research, thereby enhancing both its practical and theoretical relevance.

Keywords: CSR, corporate performance, corporate sustainability, bibliometric analysis, CSR practices, PRISMA

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Introduction

Scholarly attention to corporate social responsibility (CSR) dates back to the 1950s, reflecting a significant duration of research focus [1]. Nowadays, CSR is relevant to companies considering sustainable sourcing practices and actively engaging with communities. This comprehensive approach benefits all involved parties, as companies enhance their reputations and attract talented individuals, while also contributing to societal progress and advancing toward a more fair and sustainable future [2; 3] In this evolving environment, corporate social responsibility (CSR) has taken on a central role as a fundamental driver of corporate strategies aimed at sustainable development and subsequently enhancing a company's overall performance and impact [4].

Moreover, it's essential to acknowledge the intricate relationship between corporate social responsibility (CSR), environmental, social, and governance (ESG) criteria, sustainability goals, and the United Nations Sustainable Development Goals (SDGs) [5]. CSR practices are inherently intertwined with ESG principles, which encompass a company's environmental impact, social initiatives, and governance structures. For instance, companies integrating CSR into their operations often prioritize sustainable sourcing practices, reduce carbon emissions, and enhance energy efficiency to mitigate the environmental impact [6; 7].

Furthermore, CSR initiatives frequently involve social programs aimed at supporting local communities, fostering diversity and inclusion, and ensuring fair labor practices throughout the supply chain. Effective governance mechanisms are fundamental to CSR implementation, as they ensure transparency, accountability, and ethical decision-making within organizations. Integrating CSR practices with ESG criteria not only promotes sustainable business practices but also contributes to achieving the SDGs. Many of the SDGs, such as those addressing poverty alleviation, gender equality, and climate action, align closely with CSR objectives. By aligning their CSR initiatives with specific SDGs, companies can direct their efforts towards addressing global challenges while simultaneously enhancing their corporate reputation and creating shared value for stakeholders [8]. This interconnected approach underscores the importance of considering CSR within the broader context of sustainable development and responsible business practices [9]. However, the choice to focus on corporate social responsibility stems from its pivotal role in contemporary business practices. CSR represents a holistic approach to corporate governance, encompassing ethical, social, and environmental considerations. Compared to other similar concepts, such as corporate sustainability and corporate citizenship, CSR offers a more comprehensive framework for addressing societal and environmental challenges while also aligning with business objectives. By integrating CSR into business strategies, companies can enhance their reputation, attract stakeholders, and drive sustainable development initiatives.This deliberate selection is further motivated by the increasing significance of sustainability metrics in evaluating corporate success. Through this research, we aim to explore how CSR initiatives contribute to firms' financial outcomes, shedding light on the broader implications for corporate strategy and performance measurement. In this case, researchers have consistently delved into the ways in which CSR influences the performance of companies. This continual exploration stands as a cornerstone in advancing our understanding in this field [10;11]. In addition, the discourse regarding the interrelation between CSR and company performance has persisted over an extended period. It has evolved notably since the 1980s and 1990s, when researchers undertook pioneering initiatives, exploring new spheres. During this period, they endeavored to elucidate the true essence of CSR and delineate the extent of a company's responsibilities. In the 21st century, these ongoing discussions continue to bear significance for the research endeavors in this field [12] .

Additionally, research conducted in different countries has illustrated the relationship between corporate social responsibility and firm performance (FP). Several influential theoretical frameworks, namely stakeholder theory, resource-based view, and legitimacy theories, offer valuable insights into the mechanisms and factors through which corporate social responsibility commitment positively affects business performance. So, the impact of CSR on financial performance exhibits differing results in various studies. More specifically, some current studies suggest a positive correlation between CSR activities and a firm's financial performance, arguing that socially responsible actions can translate into improved financial outcomes [13; 14], while others showed a negative [15; 16], or a mixed [17–19] relationship. According to the researchers, the inconsistent results can be attributed to a multitude of factors, including variations in how CSR and financial performance are operationalized, differences in research methodologies, the inclusion of diverse control variables, as well as also some gaps in the theoretical basis [20; 21]. Despite abundant research over the years on the impact of CSR on company performance, the findings remain unclear and conflicting. This research extensively explores the impact of CSR on company performance. Through a meticulous analysis of diverse publications spanning from 2012 to 2022 and employing bibliometric assessment, the goal is to unveil valuable insights and discern emerging trends. The overarching objective is to offer distinctive guidance for future studies in this critical domain. Data from the Scopus database (https://www.scopus.com) served as the underpinning for the present analysis, while VOSviewer, a renowned tool for bibliometric investigations, played a pivotal role in advancing the fulfillment of research objectives.

Besides, this study significantly contributes to CSR scholarship by emphasizing its theoretical foundations and integrating bibliometric analysis with theoretical inquiry. By elucidating the theoretical underpinnings of CSR and its implications for corporate strategy and performance measurement, the research addresses a critical gap in the literature. Its interdisciplinary approach not only enhances the rigor of analysis but also informs future research agendas. Ultimately, the study aims to advance the understanding of CSR's role in shaping sustainable business practices and foster meaningful dialogue in the field.

After the introduction, the structure of this paper is as follows. In second section, the paper presents a literature review, delving into key studies that have influenced the field's progress and provides an overview of earlier bibliometric analyses examining CSR and performance. Third section provides an overview of the materials and methods used in conducting this study. The bibliometric study yielded considerable findings, which are presented in Fourth section. In conclusion, fifth section 5 addresses the study's limitations and provides recommendations for future research undertakings.

Literature Review

CSR and Its Impact on Firm's Performance

Bowen [22] wrote a book that was originally published in 1953, initiating a discourse on the integration of corporate social responsibility into strategic planning and its fundamental role in shaping business ethics. Subsequently, there has been a noticeable trend towards an emphasis on CSR in academic research. CSR in business examines why companies choose to behave in socially responsible ways, what motivates these choices, what external factors come into play, and the short-term and long-term gains they achieve [23; 24]. Appearing in the 1970 edition of the New York Times, Friedman's [25] argument that a company's primary goal is profit maximization, became a catalyst for researchers to explore how companies can authentically address their social responsibilities.

Freeman [26] introduced an alternative perspective by advocating for stakeholder theory, which suggests that businesses should prioritize addressing the concerns of their stakeholders to ensure their long-term survival and growth. This viewpoint contradicts the one mentioned earlier. Freeman [27] introduced a pyramid model to define corporate social responsibility, illustrating four essential duties that businesses hold toward their society, namely, economic, philanthropic, legal, and ethical responsibilities. This model remains influential, underlining a company's responsibilities to society and the ethical principles that should guide its actions. Carroll's subsequent research has continued to shed light on how businesses manage the interplay between economic success and social responsibility [28].Through the years, various theories emerged to provide a comprehensive understanding of the CSR business case and the implications for a business organization when it fulfills its societal responsibilities in a specific context. One theory, such as the stakeholder theory, sheds light on how businesses interact with various stakeholder groups [26; 29], and institutional theory examines the external pressures that motivate organizations to adopt sustainable practices [30; 31]. Resource-based view theory suggests that incorporating responsibility into a company's practices grants a unique advantage, differentiating companies and providing them with a distinctive competitive position [32].The instrumental stakeholder theory has emerged through the integration of concepts from stakeholder, economic, ethics, and behavioral science theories, resulting in a comprehensive framework [33].The core principle of this theory posits that through the involvement of their management, businessses create meaningful deals with stakeholders entirely built on mutual trust, cooperation and information sharing. Porter [34] , Porter and Kramer [35], well-regarded authors in the field, have brought attention to the concept of the business case for CSR. They have elucidated the idea of strategic CSR through their shared vision framework. The advancement of these theoretical frameworks and empirically validated studies, which include research conducted by such authors [36;37;38–10], has laid the groundwork for the academia to explore new avenues in understanding how CSR influences firm performance.

Bibliometric Analysis in CSR Research

There has recently been a growing interest in bibliometric research related to corporate social responsibility. In light of this, this section provides insight into studies conducted in CSR research that have employed bibliometric analysis .

Bibliometric reserach is a well-established and rigorous method for investigating and analyzing substantial amounts of scientific data. After scrutinizing three decades of CSR theory and research, De Bakker et al. [39] initiated the foremost bibliometric investigation in the scope of CSR research. Subsequently, there has been a steady increase in bibliometric research covering various sub-domains in the field of corporate social responsibility studies, reaching its peak with the greatest number of articles published in 2020, 2021 and 2022. Bibliometric research has directed its focus toward "CSR and sustainability" [40; 41], "Managing corporate social responsibility: a approach through communication" [42; 43], "Employee-centered CSR" [44], and "Gender/board diversity and CSR" [45; 46]. Bibliometric studies have additionally focused on "exploring CSR trends and research amond SMEs" [47–49], "CSR in supply chain management " [50], ''Corporate social responsibility and corporate share value"[51], "The evolution of corporate social responsibility" [52], "CSR and Marketing" [53–55]. Earlier academic publications have predominantly centered on review studies and significant research articles, providing comprehensive analyses of the fundamental principles underpinning the concepts of meaning and definitions [1; 27; 56-57] and CSR approaches [25;29; 31; 33;58]. Some review studies have explored the business case for CSR through elucidating the underlying mechanisms and assessing how a company's social responsibility affects its performance [11; 59–61] .

A considerable increase in bibliometric studies has been observed recently, especially in the domain of business research, driven by their effectiveness in handling substantial data volumes and producing valuable research results [62]. After conducting an initial assessment of the bibliometric studies mentioned above, it is clear that this paper should undertake a comprehensive bibliometric review regarding the influence of CSR on firm performance.

Table 1. Key Findings from Bibliometric Analysis in CSR Research

Study Authors	Publication Year	Main Topics
De Bakker et al. [39]	2006	Overview of CSR research trends and methodologies
Ye et al. [40]	2020	CSR and sustainability trends and practices
Ji et al. [42 ; 43]	2020,2022	Managing CSR through communication strategies
Low & Siegel [44]	2020	Employee-centered CSR initiatives and their impact
Yarram & Adapa [45]	2021	Gender and board diversity and its relationship to CSR initiatives
Oduro et al. [47]	2021	CSR trends and research among SMEs
Li et al. [50]	2022	CSR integration in supply chain management
Tarigan et al. [51]	2022	CSR's influence on corporate share value
Popov and Makeeva [12]	2022	ESG performance and board independence and its relationship to corporate financial performance

Table 1 illustrates different viewpoints within corporate social responsibility (CSR) research, showing studies with varied conclusions regarding its effect on firm performance. While some studies suggest a positive relationship between CSR practices and company success, others recognize difficulties in accurately assessing this relationship. This diversity highlights the complex nature of CSR research and the importance of thorough analysis to fully comprehend its implications for businesses.

Methodology

Database selection and search keywords

In this study, we employed a bibliometric analysis technique as a valuable research tool. Bibliometric analysis is a systematic method used to comprehensively examine the literature in a specific scientific field.

This structured process involves the identification, organization, and analysis of these documents, assessing their quality, quantity, productivity, connections, and citations. As part of this research, we procured data from the extensive Scopus database, a globally acknowledged resource for its broad journal coverage and the all-inclusive abstract and citation database [63]. Three search terms are used to uncover crucial data in the extensive field of Corporate Social Responsibility: CSR OR Corporate Social Responsibility AND Firm performance. In October 2022, data collection was initiated from the SCOPUS database, serving as the core of the research.

Table 2. Research Design

Criteria	Protocol Overview
Database	Scopus / October 2022
Search Phrase	"Corporate social responsibility" AND "Firm performance"
Boolean Operator	OR between groups
Search String	TITLE-ABS-KEY ("Corporate social responsibility" OR "CSR" AND "Firm performance") AND PUBYEAR > 2011 AND PUBYEAR < 2023 AND (LIMIT-TO (SUBJAREA, "BUSI")) AND (LIMIT-TO (DOCTYPE , "ar") OR LIMIT-TO (DOCTYPE , "ch") OR LIMIT-TO (DOCTYPE, "cp")) AND (LIMIT-TO (LANGUAGE, "English")) AND (LIMIT-TO (EXACTKEYWORD, "Corporate Social Responsibility") OR LIMIT-TO (EXACTKEYWORD, "Firm Performance")) AND (LIMIT-TO (PUBSTAGE, "final")
Location	Article title, abstract, and keywords
Languages	English

Figure 1. PRISMA approach for data gathering analysis

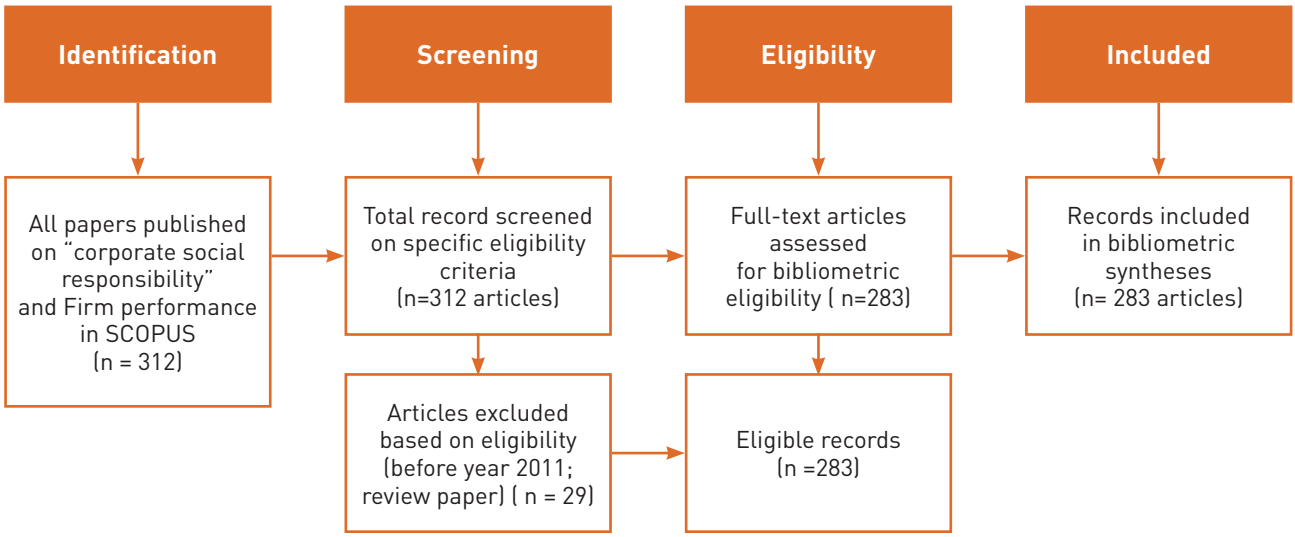
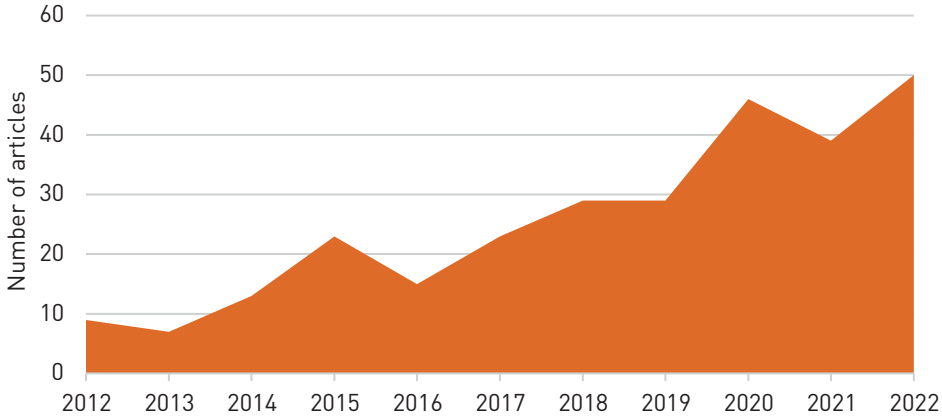


Figure 2. Annual scientific production



Defining search criteria

Applied search criteria yielded 312 published documents covering the period from 1999 to 2022. The search was specifically confined to journal articles and conference papers published in English. During a thorough analysis, we delved into various aspects, including the examination of years, subject areas, the titles of primary information sources, countries or territories, as well as identification of the most prolific authors and institutions. Nevertheless, the analysis was based on only 283 documents. A total of 29 documents spanning the years from 1999 to 2011 were excluded due to their lower relevance. Following the PRISMA flow diagram, as shown by Welch et al. [64], Figure 1 below presents an overview illustrating the information's path in the study.

Tools for Analysis

In the current study, the data has been examined using VOSviewer, a tool commonly employed in scientific research for data analysis and visualization [65]. In this manner, researchers applied VOSviewer software to scrutinize various aspects, including author keywords, subject area, co-authorship, term co-occurrence network, and country [66]. By generating network maps for each employed variable, this software enhances the structured grouping and analysis of words. The present study applied additional analytical software, including Microsoft Excel, to perform data average and percentage calculations.

Results and Analysis

Fundamental Data Analysis Overview

From 2012 to 2022, spanning a period of 11 years, the study uncovered a total of 283 documents. This encompassed 262 articles, 11 book chapters, and 10 conference papers. Through the search process, 1207 authors' keywords were obtained, bringing the overall count of authors to 225.

Annual Scientific Production and Research Trend

In the academic sphere, determining one's research focus is primarily dependent on the volume of scholarly works they have published. Analyzing the annual scientific production trend within the study's set of 283 documents highlights a comparatively limited number of articles preceding the year 2015. In both 2015 and 2018, the number of published papers showed a clear upward trend, averaging around 23

and 29 in those years, respectively. Furthermore, the peak of this growth was attained in 2020 and 2022, where totals reached 46 and 50.

Figure 2 highlights the ongoing evolution of research output, with each year contributing successively and uniquely to the expanding body of knowledge.

Disseminating Documents Across Subject Categories

From 2012 to 2022, an examination was conducted on 587 research documents concerning the link between corporate social responsibility and firm performance across 13 specific subject areas. Figure 3 reveals an in-depth exploration of the proportional categorization across the 10 primary subject areas where SCOPUS has organized the published documents by percentage. Notably, this analysis underscores the prevalence of business management and accounting, which collectively contributed to the highest number of accepted papers during the scrutinized period, amounting to 283 articles. This comprised 49% of all publications.

Figure 3. Document analysis results by subject area

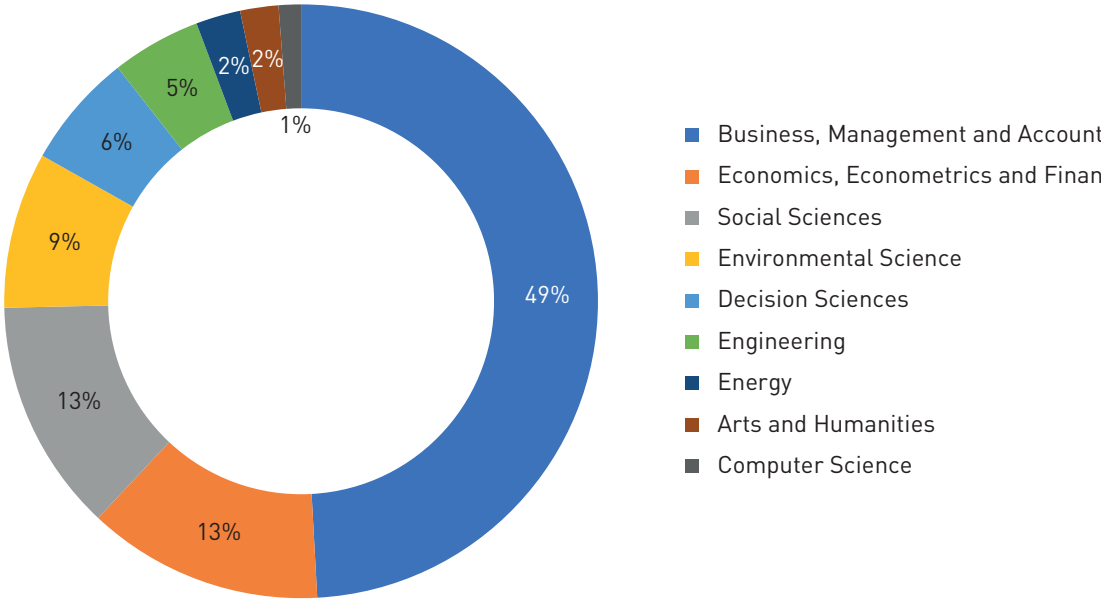
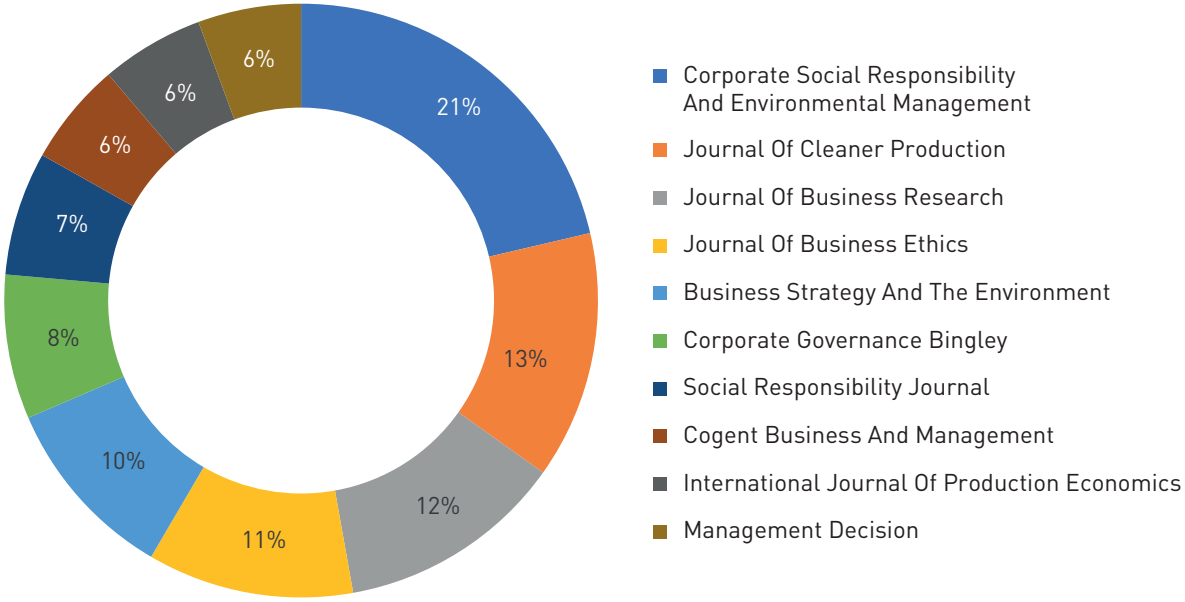


Figure 4. Key sources with the greatest number of articles



Foremost Journals for Scholarly Publications

In the following section, a systematic analysis of the sources that are most relevant or productive in articles is conducted, elucidating their significance and effectiveness in a coherent manner. Between 2012 and 2022, 283 documents concerning CSR and FP were identified across 147 journals.

Figure 4 illustrates the 10 most productive sources. The journal that exhibited the greatest level of productivity was the *Journal of Corporate Social Responsibility And Environmental Management* (21%). Following closely behind are *Journal of Cleaner Production* (13%), *Journal of Business Research* (12%), *Journal of Business Ethics* (11%), and *Business Strategy and the Environment* (10%).

Figure 5. Distribution of publications by document type

Document Categories

This section outlines various document types related to the study. Figure 5 displays a compilation of document types identified in this study, specifically, articles, conference papers, and book chapters. Journals emerged as the primary source for CSR and FP documents, constituting 93% of the total. In contrast, other sources, specifically book chapters and conference proceedings, made smaller contributions, accounting for 4% and 3%, respectively, in this study.

Bibliometric Mapping

Keyword Analysis

The co-occurrence network relies on counting and analyzing keywords, offering insights into primary topics and research trends. These keywords represent the most frequently used or significant words in the CSR and FP sphere [67]. In the analysis of the frequency of specific terms, Table 3 outlines the top eight keywords. These include corporate social responsibility with 217 mentions, firm performance with 155 mentions, CSR – 34 times, innovation – 20 times, corporate social responsibility (CSR) 12 times, corporate governance 23 times, stakeholder theory 17 times, and sustainability with 30 occurrences. Significantly, the three most prevalent terms, corporate social responsibility (CSR), firm performance, and CSR, reveal robust connections, with respective link strengths of 488, 374, and 105. This underscores a substantial relationship and correlation among these key terms in the dataset, highlighting their pivotal role in discussions pertaining to corporate studies. Furthermore, the findings revealed in Figure 6 underscore the associations between the keywords, ultimately leading to the emergence of 8 clusters, comprising cluster 1 (red) implied keywords such as corporate social responsibility (CSR) and corporate social performance, cluster 2 (green) related to sustainability, cluster 3 (dark blue) is associated with corporate governance, cluster 4 (yellow) is linked to CSR and stakeholders, cluster 5 (purple) is aligned with corporate social responsibility, cluster 6 (light pink) – with firm performance, cluster 7 (light blue) – with innovation, and cluster 8 (orange) – with stakeholder theory. In summary, each cluster represents a distinct thematic group, summarizing the key keywords and their relationships.

Moreover, Figure 7 illustrates the evolution of themes within corporate social responsibility (CSR) and firm performance (FP) research by providing a visual of the main keyword groupings. The network map shows how these keywords are linked. The use of different colors on the map reflects research intensity in 2017-2021. Yellow color marks recent and active research, while blue points to topics from earlier years. This analysis emphasizes the ongoing exploration of important subjects such as Covid-19, gender diversity, community, corporate social responsibility disclosure, environment, and legitimacy in scholarly research.

Table 3. The top 8 most frequently occurring keywords

Keyword	Occurrences	Total link strength	VOSviewer Cluster
Corporate Social Responsibility	217	488	Purple
Firm Performance	155	374	Light Pink
CSR	34	105	Yellow
Innovation	20	66	Light blue

Keyword	Occurrences	Total link strength	VOSviewer Cluster
Corporate Social Responsibility (CSR)	12	38	Red
Corporate Governance	23	75	Dark Blue
Stakeholder theory	17	65	Orange
Sustainability	30	126	Green

Figure 6. Author keywords co-occurrence network

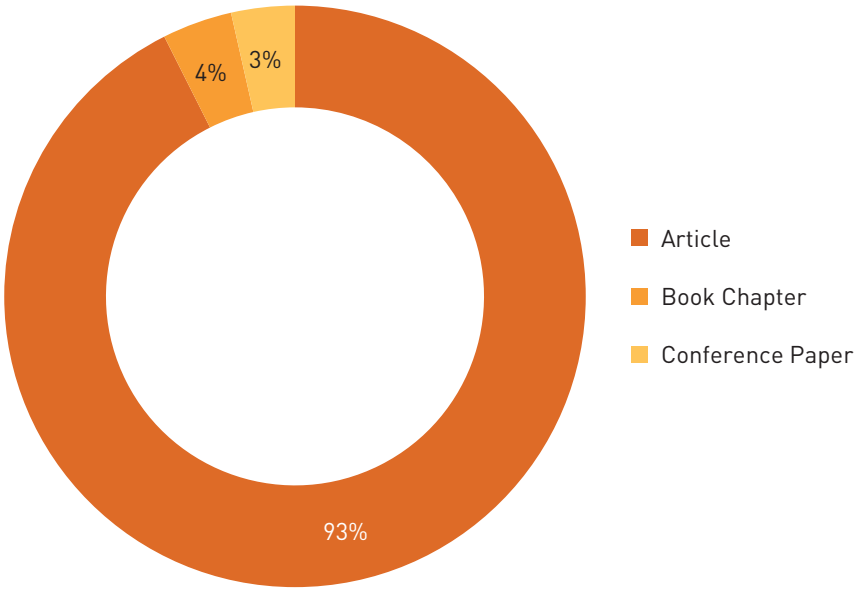
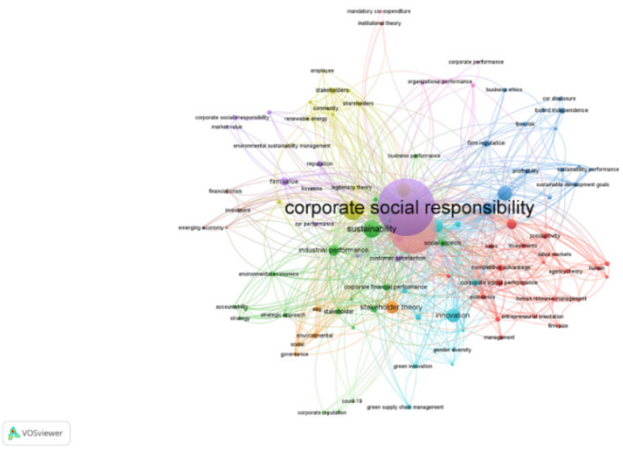


Figure 7. Keyword occurrence over the years



The co-occurrence network analysis has revealed eight distinct clusters, identified through the frequency and interrelations among keywords. Each cluster serves as a thematic cohort within the domains of corporate social responsibility and firm performance. Subsequently, we will proceed to explore the theoretical underpinnings of each cluster:

The CSR cluster revolves around the foundational concepts of corporate social responsibility and its implications for organizational behavior and performance. Discussions here are rooted in the works of Bowen, Freeman, and Carroll, emphasizing the multifaceted nature of CSR [22; 26; 27]. Carroll's CSR pyramid model, proposed in 1991, serves as a cornerstone, providing a comprehensive framework that encompasses economic, legal, ethical, and philanthropic responsibilities. This theoretical model suggests that businesses have obligations beyond profit maximization, including legal compliance, ethical conduct, and philanthropic contributions. By drawing on Carroll's model, this cluster delves into discussions exploring how businesses navigate these various responsibilities and their impact on organizational behavior and performance. Conversely, the light pink cluster delves into empirical research on the link between CSR initiatives and organizational outcomes. The resource-based view (RBV) suggests that CSR initia-

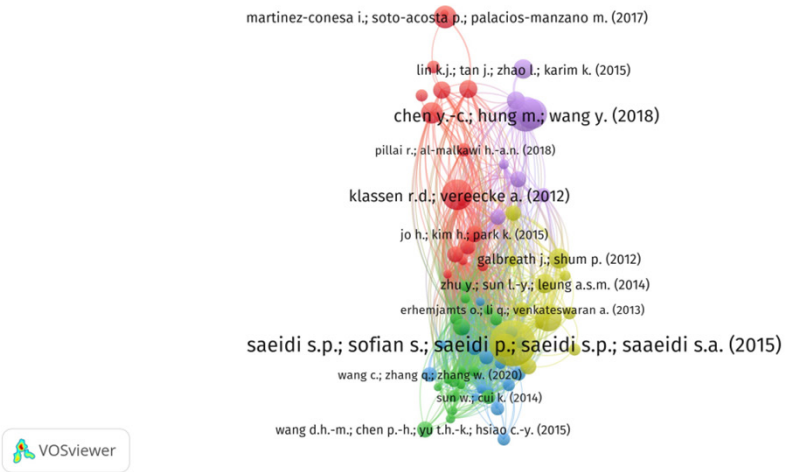
tives can lead to improved firm performance by enhancing reputation, attracting talent, and fostering innovation [32]. Porter and Kramer's work on creating shared value may also be relevant to discussions within this cluster [35]. Meanwhile, the yellow cluster revolves around stakeholder theory and its implications for CSR practices. Theoretical frameworks for this cluster are informed by Freeman's works [26], which explore how businesses engage with stakeholders to address societal concerns and enhance organizational legitimacy. Moving forward, the dark blue cluster focuses on corporate governance. Carroll's seminal research [28] provides insights into how businesses manage the interplay between economic success and social responsibility, highlighting the importance of ethical conduct within organizations. In the green cluster, the authors explore sustainability. Insights from Porter and Kramer [35] shed light on creating shared value, suggesting that CSR initiatives benefit both society and firms by attracting talent, fostering innovation, and enhancing reputation. The light blue cluster delves into innovation within the context of CSR and firm performance. This cluster investigates the intricate relationship between corporate social responsibility initiatives and the fostering of innovation within organizations. Insights drawn from Porter's seminal works [34] shed light on how CSR practices stimulate innovation, thereby creating value and fostering competitive advantage in dynamic market environments. Through rigorous empirical analysis and theoretical frameworks, this cluster aims to elucidate the mechanisms through which innovation contributes to organizational success and societal well-being. Finally, the orange cluster focuses on stakeholder engagement strategies within the realm of CSR. Grounded in the theoretical underpinnings of stakeholder theory [26], this cluster endeavors to explore how businesses effectively engage with diverse stakeholder groups to address societal concerns while simultaneously enhancing organizational legitimacy and performance. Freeman's seminal perspectives [26] serve as a guiding framework, emphasizing the significance of meaningful stakeholder relationships built on trust, reciprocity, and shared value creation. Through rigorous empirical analysis and theoretical synthesis, this cluster seeks to advance our understanding of stakeholder engagement practices and their implications for sustainable business practices and societal impact.

Bibliographic Coupling

Bibliographic coupling pertains to the association between two documents that share a common reference in their citations [78]. In order to improve the accuracy and in-depth analysis of CSR and performance, a 50-citation threshold was set. Out of a total of 283 documents, 74 met the threshold. In total, five clusters emerged. Clusters 1 and 2, with their distinctive red and green colors, were the largest (comprising 17 articles). The first category, identified by the red color, primarily focused on studies specifically linked to CSR sustainability practices and firm performance,corporate environmental responsibility and firm performance, CSR and its relationship to sustainable developement and firm sustainability performance. When examining cluster 2, the articles primarily centered on the disclosure of CSR and its impact on firm performance, with additional attention of the role of marketing and differentiation in strenghtening that link. In cluster 3 (blue), which incorporates 16 articles that focus on corporate governance mechanisms, ESG practices, green innovation and employee-focused corporate social responsibility. Cluster 4 (yellow) comprises 13 articles generally centered on sustainable leadership and firm reputation.The final cluster (purple) includes 11 articles related specifically to mandatory CSR reporting .

Furthermore, in analyzing bibliometric coupling, it was noted that Saeidi et al. [79] and Chen et al. [80] received the most citations in this field for their valuable work in exploring the relationship between CSR and performance. Using VOSviewer, Figure 9 demonstrates the visualization of the analysis's scientific map.

Figure 9. Bibliographic couplings using VOSviewer



The observed bibliographic coupling within the identified clusters not only underscores the interconnectedness of scholarly discourse, but also elucidates the theoretical underpinnings driving research in each thematic area. By examining the co-citation patterns among key articles, we can discern the emergence of cohesive frameworks and theoretical lenses that shape our understanding of CSR dynamics and their implications for organizational behavior and performance.

Within Cluster 1, scholars converge on the significance of CSR sustainability practices in enhancing firm performance. Recent studies by Carroll and Shabana [1] and Carroll [2] provide empirical evidence in support of the positive impact of CSR initiatives on financial outcomes. Moreover, Sharma [3] offers insights into the broader societal expectations placed on organizations regarding sustainability efforts. Furthermore, Boukattaya, Achour, and Hlioui [20] contribute to understanding the relationship between disclosure of CSR practices and firm performance, thereby expanding our comprehension of CSR's role in organizational success and its implications for financial performance. These findings collectively contribute to the literature by reinforcing the link between CSR activities and firm performance, providing valuable insights into the mechanisms through which CSR practices influence financial outcomes.

Cluster 2 enriches CSR literature by highlighting the crucial role of CSR disclosure in shaping firm performance, particularly concerning environmental sustainability. Studies such as those by Martynova and Lukina [4] investigate the impact of ESG ratings on financial performance, shedding light on how environmental, social, and governance factors affect organizational outcomes. Additionally, Zheng, Luo, and Maksimov [23] explore achieving legitimacy through corporate social responsibility, offering insights into how firms in emerging economies navigate CSR practices to enhance their reputational and financial standing. These investigations contribute to theoretical frameworks by elucidating the mechanisms underlying the CSR-performance nexus. Furthermore, the emphasis on integrating CSR practices into organizational operations and communication strategies underscores their strategic significance in driving competitive advantage and long-term sustainability. The bibliographic coupling observed in this cluster demonstrates the interconnectedness of these studies, which collectively advance our understanding of how CSR disclosures influence firm performance, providing a robust theoretical foundation for future research.

The third cluster advances CSR literature by elucidating the role of corporate governance mechanisms, ESG practices, green innovation, and employee-focused CSR in achieving sustainable business practices. Through bibliographic coupling, the cluster reveals how these elements are interconnected, providing a comprehensive framework that links internal governance structures with external sustainability outcomes. By examining the synergistic effects of robust governance and proactive ESG strategies, the cluster contributes to theoretical models that explain the mechanisms through which CSR initiatives drive organizational performance and stakeholder engagement. The inclusion of works by Ali et al. [14] on the moderating role of CSR in corporate governance and financial performance, De Stefano et al. [9] on the HR role in CSR and sustainability, and Torres et al. [7] on CSR/ESG instruments underscores the strategic value of integrating CSR into core business operations and highlights the importance of human capital in sustainability efforts.

Cluster 4, which centers on sustainable leadership and firm reputation, highlights the theoretical importance of corporate social responsibility (CSR) in shaping organizational outcomes. Kankam-Kwarteng et al.[55] and Helfaya and Aboud [5] contribute to this cluster by examining the relationship between CSR practices and firm reputation, demonstrating how sustainable leadership cultivates positive stakeholder perception and improves financial performance. Integrating these studies into the cluster underscores the critical role of CSR integration into leadership strategies. This emphasizes the significance of CSR in fostering trust, nurturing stakeholder relationships, and driving sustained organizational growth over the long term. Additionally, the inclusion of these studies enriches the theoretical understanding of how CSR initiatives influence firm reputation, providing insights into the mechanisms through which sustainable leadership practices contribute to organizational success.

The final cluster highlights the increasing importance of transparency and accountability in corporate practices. The inclusion of studies such as Fahad and Busru [16], which explore the relationship between CSR disclosure and firm performance in emerging markets, underscores the global significance of CSR initiatives. These studies emphasize the role of mandatory reporting requirements in shaping corporate behavior, driving sustainable business practices, and enhancing long-term financial performance. Additionally, Tahri and El Khamlichi [8] contribute by examining the disclosure and communication of CSR practices in a specific context, providing insights into how companies navigate mandatory reporting requirements and communicate their CSR efforts to stakeholders. By shedding light on the impact of CSR disclosure on firm performance, particularly in the context of emerging markets, this cluster contributes to our understanding of the mechanisms through which CSR initiatives can create value for both companies and society at large.

Co-Authorship Analysis

The co-authorship network elucidates the collaborations between authors across diverse research fields, revealing the associations established through their published articles. In Figure 10, an illustrative overview unveils the network of collaborations among authors, shedding light on the relationships between contributors and presenting a carefully designed demonstration with the help of VOSviewer software. This deepens the insight into how CSR and performance align in collaborative dynamics. Moreover, when examining Figure 10, the visual representation enriches

the understanding of how the network is organized. Authors are illustrated as circles, and the size of each circle indicates the number of connections. The lines connecting authors represent their collaborations, while the different colors of the circles indicate the various groups in which authors work together. Within the context of CSR and firm performance, authors joined forces, engaging 13 contributors in the creation of 6 clusters. Each contributor played a key role by making a significant contribution with at least one article. Seoki Lee stood out as a prominent author, contributing 8 papers. Notably, Lee occupied a leading position, achieving a noteworthy 15th ranking in total link strength, emphasizing the impact of their collaborative efforts in this field.

Figure 11 sheds light on the the backgrounds of collaborating co-authors, predominantly from the United States (US). This aligns with the findings in Table 3, indicating a higher number of papers in this field originating from the US. Specifically, the USA contributed 78 documents, accumulating 5231 citations based on document count, with a total link strength of 46. China, as another significant contributor, accounted for 44 documents, cited by 1967 other documents, and demonstrated a total link strength of 34.

Figure 10. Influential Authors generated using VOSviewer

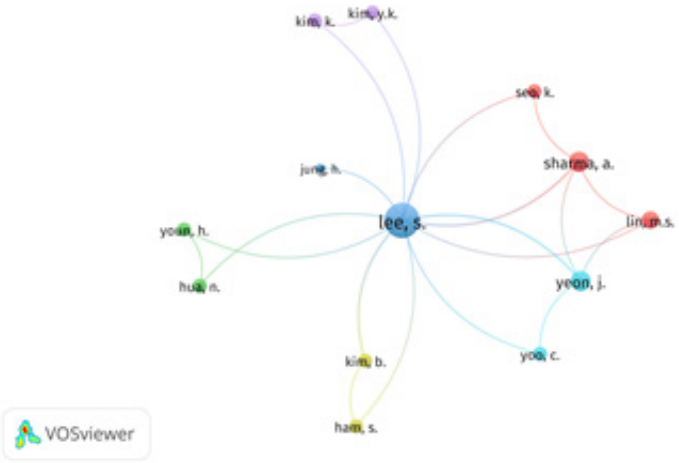
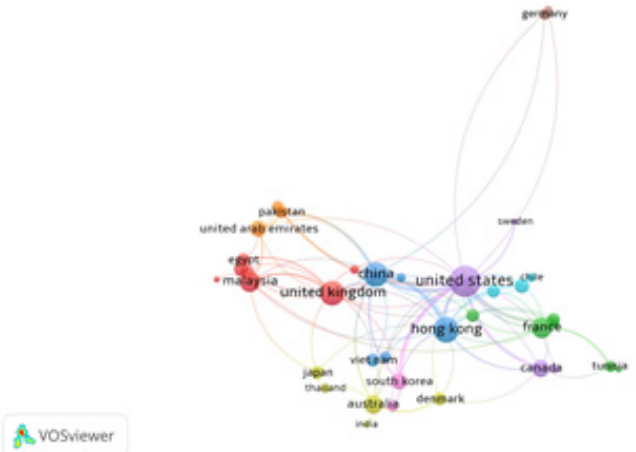


Figure 11. Country collaboration network



Hong Kong, identified as the third major contributor, presented 20 documents and received 1507 citations. These three entities exemplify a dynamic collaboration, underscoring their joint commitment to advancing knowledge and understanding within this research domain.

In addition, nine distinct clusters are formed, emphasizing the engagement of a total of 19 countries. Notably, Cluster 1, portrayed in purple, highlights the connections among developed entities on a global scale, with the USA serving as the hub. This particular cluster includes three contributing countries: Belgium, Canada, and Sweden. Through their close collaboration, these countries are investigating how corporate social responsibility impacts the performance of businesses. East Asian nations are linked in the blue cluster, with contributing countries such as Vietnam, Taiwan, Macao, and Hong Kong. China, which have the highest link within this cluster, plays a notable role. These nations actively collaborate in the examination of corporate social responsibility and firm performance, as depicted in Figure 11. Within this context, the study underscores the significant contributions of China and the USA to global collaborations addressing CSR issues and their implications for corporate performance.

Table 4. Prominent country by documents and citations ranked based on Scopus

Rank	Country by Documents	Documents	Rank	Country by Citation	Citations
1	United States	78	1	United States	5231
2	China	44	2	China	1967
3	Hong Kong	20	3	Hong Kong	1507
4	Malaysia	20	4	Malaysia	1241
5	Iran	19	5	Iran	978
6	Spain	17	6	Spain	946
7	Italy	17	7	Italy	820
8	Australia	15	8	Australia	815
9	South Korea	14	9	South Korea	757
10	Canada	13	10	Canada	747

Co-authorship analysis reveals a robust international collaboration in CSR research, particularly among the United States, China, and Hong Kong. This finding underscores the theoretical importance of collaborative efforts in advancing CSR knowledge. Notably, Seoki Lee's significant contributions underscore the collaborative efforts essential for advancing knowledge in this domain, aligning with Carroll's [2] perspective on the importance of collective research endeavors. The significant presence of the United States, China, and Hong Kong underscores the global participation in CSR research, resonating with studies by Tanggamani et al. [84] and Masum et al. [19]. These studies highlight the importance of cross-national collaborations in advancing CSR knowledge and understanding, emphasizing the relevance of diverse perspectives in addressing complex societal challenges. Recent contributions by researchers such as ElAlfy et al. [52], Kankam-Kwarteng et al. [55], and Usman et al. [21] further elucidate the contributions and collaborations of these countries in CSR research, reflecting the evolving landscape of international cooperation. This global perspective enhances our comprehension of CSR's impact on firm performance and highlights the need for context-specific approaches to corporate responsibility."

Conclusion

The current study offered an opportunity to assess trends relevant to CSR and firm performance in bibliometric analysis studies published between 2012 and 2022. In this framework, the analysis was conducted using 283 documents based on SCOPUS Database, and the resulting data was examined with the assistance of VOSviewer.After thoroughly reviewing overall performance, an analysis of keyword co-occurrence, thematic evolution, and reference co-citation was carried out employing science mapping through network maps.

After years of studying the relationship between corporate social responsibility and a company's performance, researchers remain committed to understanding the complex dynamics of this connection. The growing number of recent publications underscores their continuous efforts in this exploration. According to Scopus classification, several publications on corporate social responsibility were found in journals related to business, management, and accounting. Among highly influential journals, Corporate Social Responsibility and Environmental Management garnered the most significant number of publications. Across the years, the majority of published works in the Corporate Social Responsibility and Environmental Management journal have included studies exploring CSR and corporate performance. Others, like the Journal of Cleaner Production, Journal of Business Research, and Journal of Business Ethics, among others, have been identified by our studies. The influence of these journals, along with their impact factor, has contributed to an increase in studies examining the relationship between CSR, ESG disclosure, sustainability reporting, and firm performance.

Investigations revealed that the literature in this field received a more significant contribution from developed countries, of which the USA and China are the most active countries in terms of publications. Collaborations between countries were predominantly centered around developed countries such as the United States, Canada, Germany, France, Australia and Italy. Collaborative studies at the regional level are notably significant, with China demonstrating the strongest link strength among East Asian countries. Moreover, India establishes the most relationships with other developing countries worldwide.

Further, cartography analysis reveals valuable insights into the relationship of corporate social responsibility and firm performance. Going beyond just the main search terms used in the study, through exploration it was discovered

that sustainability is the primary research area in studies highlighting CSR and performance. Corporate governance, innovation, firm reputation, and CSR disclosure are also considered important topics. Again, the recently emerged themes include ESG practices, CSR reporting, green innovation, and sustainability performance. Companies are heeding more attention to how they handle social responsibility, particularly in relation to their performance. These specific findings have led to an increase in the number of studies published since 2020 due to the widespread effects of the COVID-19 pandemic.

Bibliometric analysis explored research outcomes across various topics on a global scale. Throughout the analysis, a thematic evolution map grouped keywords into eight clusters. These clusters bring attention to main themes and cross-cutting themes, providing valuable insights for guiding future studies. In this case, some key discoveries on vital themes focusing on CSR are outlined for future research articles.

First, an interesting research avenue entails an assessment of the influence of the recent Covid -19 pandemic on studies concerning CSR and the performance of companies. This extends beyond their primary stakeholders to encompass the entire community [81; 82].

Second, by thoroughly analyzing yearly thematic trends in research, institutional theory has distinctly emerged as a notable theme, particularly in the exploration of developing countries such as China, Hong Kong, and India. This growth shows the role of institutional factors in enhancing corporate social responsibility and boosting of corporate performance [83].

Third, in the analysis map, mandatory CSR expenditure and CSR disclosure are considered two major themes that emerged in the analysis map between the years 2017 and 2021. In the same perspective, implementing mandatory CSR is viewed as a positive strategy to enhance a firm's performance [84]. Besides, scholars are increasingly focusing on CSR reporting, recognizing it as a tool used by companies to legitimize communication with stakeholders [85; 86].

Fourth, gender diversity appeared as a transversal topic interconnected to CSR, as shown in the analysis map for 2017-2021. In this sense, the board of directors plays an imporant role in guiding the business strategy. Also, taking into account the inclusion of women in these decisions might positively shape the choices related to CSR and assist in making businesses more responsible and sustainable [87]. This indicates that there is still scope for investigation, for instance, the depth of the relationship between gender diversity, CSR practices and performance. This could capture the attention of diverse stakeholders, motivating more companies to actively participate in CSR initiatives [88].

Fifth, society and investors recognize the value of ESG practices, demonstrating a shared concern in regard to more than just financial performance, like prioritizing commitment to environmental and social responsibilities. The importance of ESG practices is acknowledged by society and investors who are not only interested in financial performance, but also in corporate environmental and social performance. Instead of exclusively concentrating on financial gains, companies should actively integrate efforts to attain development goals into their strategic and financial decisions at all levels [89]. This offers a host of captivating avenues for exploration in future research possibilities.

Sixth, in alignment with the thematic evolution map, advancements in researching CSR and how it affects businesses have revealed various themes, as discussed in this study. Some current investigations have included such stimulating themes associated with green supply chain management [90], innovation [91], and human resource management [92]. These outputs highlighted a need to explore in future research the impact of CSR practices on internal stakeholders, specifically employees, attaining a sustainable performance requirement for businesses not only to implement social responsibility but also to take into consideration environmental awareness.

This bibliometric study has revealed the following insights. On the one hand, this research article significantly advanced the understanding of CSR and firm performance literature by systematically categorizing 283 documents from 2012 to 2022 within clusters, offering a distinct methodology that not only facilitated exploration of potential future research directions but also provided a comprehensive contribution to the field. Likewise, there's been a noticeable boost in CSR publications in 2022 when compared to both 2021 and 2020. The main spotlight remains on subjects related to business, management, and accounting. Also, the *Journal of Business Research* stands out with a noteworthy 1709 citations. Its rising trend not only points to a growing influence but also emphasizes the significant impact it has had on the field of CSR and firm performance.

While this study's findings contribute positively to the relevant field, it's important to note certain constraints. Centering solely on the Scopus database might have omitted important publications, potentially limiting the depth of the research. Although Scopus provides a valuable resource, exploring additional databases like Web of Science and Google Scholar provides a more comprehensive picture of the research landscape. Moreover, an interesting finding of the analysis is the limited collaboration among scholars studying CSR practices and firm performance. This underscores a need for greater interdisciplinary research initiatives. Beyond the numbers, there's a wealth of qualitative information waiting to be explored. By employing content analysis alongside bibliometrics, researchers can uncover deeper meaning and gain a more comprehensive view.

Finally, COVID-19 demonstrated that the world is interconnected and vulnerable. This emphasizes the need for companies to be responsible through corporate social responsibility. Being responsible, especially for employees, communities, and the environment, helped companies handle challenges better during the pandemic. This difference shows that companies should care about more than just making money. They should consider how they affect people and the planet by including social and environmen-

tal aspects in their main strategy. In this particular context, this study acts as a guide, leading scholars and researchers to explore how CSR relates to a company's success. It encourages a comprehensive investigation, considering the theoretical, practical, and conceptual aspects of this relationship.

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Social Norms and Cost of Equity: Empirical Examination in Indonesia

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Abstract

This paper provides evidence of the effect of social norms, as measured by sin stock status, on the cost of equity capital. We consider Indonesian publicly traded sin stocks that produce alcohol and tobacco. While previous studies focused on whether sin and saint stocks have different financing preferences, we examine how these companies are charged differently in terms of their cost of equity capital. Our research sample consists of companies listed on the Indonesian Stock Exchange from 2016 to 2020. Regression analysis proves that sin stock status has a significant influence on equity capital costs. There is an extra premium for sin stocks, as they are perceived to be riskier by investors in the market. Our results make a significant contribution to the emerging literature on social norm-based investing, demonstrating a major impact on both corporate finance and investment management decisions. The study's sample is restricted to publicly traded companies in Indonesia from 2016 to 2020, potentially limiting the generalizability of its findings to other countries or periods. Further research could broaden the scope of analysis and delve deeper into the factors that influence the cost of equity for sin stocks in various contexts.

Keywords: cost of equity, financing decision, sin stock, social norm

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Introduction

Faith-based or norm-based investment strategies have garnered significant attention in financial studies in recent years. In the United States, norm-based mutual funds represent over 10% of total assets under management, with more than 200 such funds reported by the Social Investment Forum in 2006. Socially Responsible Investing (SRI), encompassing ethical and moral principles, involves either favouring companies with environmentally friendly or ethical operations or excluding companies deemed unethical, such as those producing tobacco or alcohol or engaging in gambling.

The term "sin stock" was coined by H. Hong and M. Kacperczyk [1], who identified such firms as benefiting from easier access to funding from entities less influenced by societal norms. While perceiving sin stocks as unethical investments, numerous studies indicate their superior market performance compared to saint stocks [2–4]. Sin stocks exhibit characteristics similar to value stocks, trading below their intrinsic value [1]. This undervaluation prompts sin stocks to prefer debt over equity as their primary funding source [5].

Notably, institutional investors often avoid sin stocks due to public scrutiny despite their high performance [6]. In contrast, individual investors, unconstrained by social pressures, are more willing to hold sin stocks. This avoidance by institutional investors has been consistently observed across studies, further reinforcing the undervaluation of sin stocks and their reliance on debt financing.

Despite the increasingly global focus on norm-based investing, research has predominantly examined contexts in Catholic or Christian-majority countries. For example, H. Hong and M. Kacperczyk [1] and R.B. Durand et al. [5] analyse sin stocks primarily in the United States and other Western countries where Christian or Catholic values significantly influence societal norms and investment behaviours. F.J. Fabozzi et al. [7] also explore controversial industries in Western markets, focusing on how religious and ethical considerations shape investment patterns. Similarly, J.M. Salaber [8] investigates sin stocks across European markets, with a particular emphasis on how different degrees of religiosity in Christian-majority countries affect the risk and return of these investments. These studies collectively highlight the gap in understanding how norm-based investments operate in Muslim-majority contexts like Indonesia. Our study investigates the implications of sin stock status in Indonesia, focusing on the tobacco and alcohol industries, which are particularly sensitive to societal norms in a predominantly Muslim context. This research contributes to the literature by analysing the potential downsides of sin stock status, such as the challenges posed by negative perceptions and regulatory pressures. Furthermore, it expands the scope of previous studies by exploring differences in the cost of capital between sin and non-sin stocks, offering new insights into how societal norms and ethical considerations influence financing decisions and capital structure.

Literature review

Social norms play a pivotal role in shaping financial decisions, particularly for companies producing goods or services perceived as unethical, commonly referred to as "sin stocks". These firms – operating in industries such as tobacco, alcohol, and gambling – have been the subject of numerous studies, yet much remains unexplored regarding their financial performance and the broader implications of societal norms, particularly in non-Western contexts.

The performance of sin stocks has been extensively studied in Western, Christian-majority countries. H. Hong and M. Kacperczyk [1] identify sin stocks as undervalued due to societal norms and demonstrate their reliance on debt financing over equity. They attribute the undervaluation to the "norm-constrained hypothesis", where institutional investors avoid sin stocks due to reputational concerns, resulting in risk-adjusted abnormal returns (α). This outperformance is supported by studies such as F.J. Fabozzi et al. [7], who found annual excess returns averaging 11.15% across 21 countries in 1970–2007, and J. Chong et al. [9], who demonstrated the Vice Fund's superior performance compared to socially responsible funds.

[8] further corroborates the defensive nature of sin stocks, showing that these companies outperform during market downturns due to the addictive nature of the products they produce. However, their performance diminishes during market upswings. Similarly, N. Areal at al. [10] find that sin stocks exhibit higher systematic risk (β) in low-volatility regimes and lower risk in high-volatility regimes, contributing to their uneven performance across market conditions.

However, there are also contrasting findings. A.G. Hoepner and S. Zeume [11] argue that the Vice Fund's abnormal returns are not statistically significant, citing trading instability as a potential detractor. Furthermore, D.P. Liston [12] finds that abnormal returns for sin stocks disappear after controlling for investor sentiment, suggesting that market inefficiencies may play a role in their observed performance.

Despite the wealth of research on Western markets, there has been limited exploration of sin stocks in Muslim-majority countries like Indonesia, where societal norms against alcohol and tobacco are particularly strong. P.D. Pratiwi [13] provides one of the few studies on Indonesian sin stocks, examining their financing decisions but leaving broader financial implications, such as cost of capital and risk-adjusted returns, unaddressed. Given Indonesia's unique cultural and regulatory landscape, the interplay between social norms and financial outcomes remains a critical area for investigation.

Institutional setting

Our analysis of the effect of social norms on investing behaviour within the stock market follows the approach of H. Hong and M. Kacperczyk [1], focusing on the industries known as the "Triumvirate of Sin": tobacco, alcohol, and gaming. E. Fama and K. French [14] define sin stocks

more broadly as companies within the entertainment, food and beverage, soda, and hotel industries. S. Leventis et al. [15] view alcohol, gambling, tobacco, guns, firearms, and the nuclear industry as sin companies. For our research, we exclude the gaming industry since, in Indonesia, no public gaming companies exist for the moment. Tobacco and alcohol are viewed as "unethical" – especially alcohol, since Indonesia is the country with the highest number of Muslims in the world, and drinking alcohol is strictly prohibited. While alcohol is perceived as a sin product because it is prohibited by the Quran, negative social norms on tobacco started to emerge recently due to the health consequences of consuming tobacco-based products such as cigarettes.

Tobacco in Indonesia

With a population exceeding 260 million, Indonesia is indisputably the largest economy in Southeast Asia. However, this potential is under threat due to the high number of deaths associated with smoking. Approximately 10 percent of smokers in Southeast Asia are found in this country, with half of them being Indonesian. To address this issue, the Indonesian government has implemented Government Regulation (PP) No. 109 of 2012, demonstrating its commitment to mitigating the adverse effects of tobacco use among its citizens. This regulation imposes various restrictions on tobacco companies. For instance, they are only permitted to advertise and promote their tobacco products on television or radio between 9:30 p.m. and 5 a.m. local time. Furthermore, promotional materials are prohibited from displaying the actual cigarette product, while cigarette packages are required to display health warnings.

Despite all the efforts to control tobacco, some still view government measures as being half-hearted. Tobacco accounts for almost 10 percent of Indonesia's tax revenue and employs more than 2.5 million workers in farming and manufacturing processes. Thus, it is hardly surprising that the government is reluctant to strengthen restrictions on tobacco companies, as this could damage the industry and the economy in general.

Alcohol in Indonesia

In some parts of Indonesia, drinking is part of culture. Traditional alcoholic beverages such as *Arak Bali* (Bali) and *Ciu* (Java) vary across different provinces in Indonesia. Alcoholic beverages from other countries, such as beer, wine, and whiskey, are also popular and can be easily found in Indonesian cities. However, as Indonesia is the largest Muslim nation in the world, the issue of alcohol regulation has always been controversial, with conservative Islamist groups asking for a ban on sales, distribution, and consumption.

In 2015, the government enacted the Ministry of Trade Regulation No. 06/M-DAG/PER/1/2015 on the Control and Supervision of Procurement, Distribution, and Sale of Alcoholic Beverages, prohibiting the sale of alcoholic beverages in all Indonesian minimarkets. Moreover, it has elevated the import tax on alcoholic beverages, raising the overall price of drinking and turning people toward the black market or the consumption of methanol-laced drinks, many of which contain non-food grade materials and are therefore hazardous to health.

Hypothesis development

Due to the adverse effects of tobacco and alcohol, a company manufacturing or selling these products will be perceived as sinful and less socially responsible by investors. This impacts the company's decisions, especially when it is looking for a source of funds. As the company has a negative image, managers will be more reluctant to use equity-based funds since there is a higher chance of being scrutinized by the public, media, or even investors; this, in the end, affects stock performance. Sin stocks also tend to be undervalued by the market. Institutional investors such as pension funds, universities, religious organizations, banks, and insurance companies [1] are also less likely to have sin stocks within their portfolio as a result of social norm pressures. While institutional investors are reluctant to hold sin stocks, contrasting behaviour is shown by individual investors, who can keep sin stocks in their portfolios without having to worry about social pressure.

A. Goss and G.S. Robert [16] give evidence of the relationship between socially responsible firms and the cost of debt, demonstrating that sin stocks tend to choose debt over equity to finance their projects as it is cheaper, and creditors only need to verify the company's ability to pay its debts, neglecting other variables. Creditors do not take socially responsible activities into account when taking decisions on credit realization. This result is also supported by R.B. Durand et al. [5] and H. Hong and M. Kacperczyk [1], who agree with [16] that sin stocks tend to choose debt financing since it is cheaper than equity financing, which is more sensitive to corporate reputation issues.

As sin stocks are often perceived as riskier, especially by investors mindful of corporate social responsibility who are afraid of facing regulatory penalties or legal challenges, a higher return on equity is required to convince investors to bear the risk. This argument is supported by F.J. Fabozzi et al. [7], who show that companies involved in controversial industries often trade at a discount, increasing their cost of equity to counter negative perceptions. Moreover, sin stocks, which are more exposed to political and regulatory risks, tend to have more volatile stocks due to uncertainty in profitability and future cash flows, leading to a higher cost of equity [8].

Sin stocks often try to mitigate negative perceptions by improving the quality and transparency of financial reporting to reduce information asymmetry. While this can help attract investments, it also indicates that sin stocks face higher scrutiny from equity investors who demand more detailed information. A company's effort to improve transparency can furthermore result in an increased cost of equity, as it signals the need to compensate for heightened investor concerns [17]. Sin companies also try to reduce the damage by engaging in charity activities and donating significant amounts of money. Thus, we expect sin stocks to have a higher cost of equity:

H1: Sin stocks positively affect the cost of equity.

Data and methodology

Data

We use accounting data from 2016–2020 obtained from financial reports published by the Indonesian Stock Exchange (IDX). This period was chosen due to several reasons. First, in 2016, the Indonesian government raised taxes on tobacco products for the first time since 2012[1]. These changes potentially impacted the financial performance of sin stocks and influenced investor behaviour in the capital market. Second, in the same year, new cigarette advertising regulations were applied both online and off, restricting tobacco advertisements in various public spaces[2]. This could have potentially evoked investor reactions in the capital market. Third, the Indonesian government continued to raise the cigarette tax over the decade, culminating in a 23% tax increase in early 2020. Finally, in 2018, IDX introduced the SRI-KEHATI index, which tracks company ESG practices. This could have been seen as an indicator of rising concern for ethical investing in Indonesia, putting more pressure on both sin stocks and investors who include sin stocks in their portfolios. We exclude stocks from the financial sector, especially the banking and insurance industry, due to the different nature of that industry, which is heavily regulated in Indonesia and has different forms of capital structure. In particular, banking and insurance companies usually have high debt ratios, affecting their financial behaviour and making it different from that of other industries.

Sample selection procedure

The study uses data from companies that were publicly listed on the Indonesian Stock Exchange (IDX) from 2016 to 2020. To generate the final sample, we utilize the purposive sampling method: 1) identification of companies that were available five years in a row during our observation period; 2) exclusion of companies from the financial sector; 3) elimination of companies with incomplete values; 4) trimming the data by winsorizing it at 1% to reduce outliers. Applying these criteria, we get a sample size of 654 observations, which consist of both sin and non-sin stocks.

Dependent variable

In this study, we utilize Easton's model [18] to assess the cost of equity. Several prior studies have examined the cost of equity by employing a weighted average of various models with the aim of reducing estimation errors [18–22]. However, we stick to Easton's model because it has shown a high correlation with other widely accepted models mentioned earlier, as well as with the model from N. Hu et al. [23], which reveals a significant positive correlation between the models and the 1% alpha level. The cost of equity capital (CC_t) is calculated as the square root of the difference in EPS (net profit at t divided by shares outstanding at t) divided by P_0 (the closing price of stock at t = 0):

$$CC_t = SQRT\ [(EPS_{t+1} - EPS_t)/\ P_0]. \quad (1)$$

Independent variable

The independent variable in this study is Sindum, a dummy variable with a value of 1 if the company is involved in the production or sale of tobacco or alcohol as its primary business activity and 0 otherwise. This classification is based on the definitions and industry categorizations provided by previous studies [1; 14; 15]. If a company is diversified, Sindum takes the value 1 if more than 50% of its revenue that year comes from tobacco or alcohol. If the company's core operations are not focused on sin products, it is classified as non-sin (value 0). These criteria follow the approach of H. Hong and M. Kacperczyk [1]. The data used to classify companies into sin and non-sin industries comes from company financial reports and industry classifications published by the IDX. Our industry classification follows the classification by IDX (IDX-IC). The data sources provide detailed information on company activities and revenue breakdowns, which we use to help identify sin stocks.

Control variables

In this research, we use control variables that empirical studies have demonstrated to have an impact on a company's cost of capital (see, in particular, Boubakri [22]). These variables include Company Size (measured in total assets), Leverage (expressed as the ratio of debt to total assets), and Investment Opportunity Set (calculated as the ratio of the book value to the market value of equity). Since most of these are accounting variables, we collect them from financial reports published by IDX.

Modelling

We conduct a regression based on the following formula:

$$CC_{,t} = \alpha_{i,t} + \beta_1\ Sindum_{,t} + \Sigma\ \beta_n\ Control_{i,t} + e_{\ i,t,} \quad (2)$$

where

CC – cost of equity capital (CC);

Sindum – dummy for sin stock: 1 if the company is categorized as a sin stock, and 0 otherwise;

Control – control variables Company Size, Leverage, and Investment Opportunity Set.

Empirical results and analysis

Descriptive statistics

An analysis of the descriptive data presented in Table 1 allows us to draw several conclusions. For instance, the mean cost of capital is relatively low when compared to the maximum value, indicating that the majority of the cost of capital values within the sample are on the lower side. Additionally, the average value of Sindum stands at 0.069, implying that there are relatively few sin stocks compared to non-sin stocks in the dataset.

[1] Ministry of Finance No. 147/PMK.010/2016.

[2] Undang-Undang Nomor 19 Tahun 2016 tentang Perubahan Atas Undang-Undang Nomor 11 Tahun 2008 tentang Informasi dan Transaksi Elektronik.

Table 1. Descriptive Statistics

Variable	N	Mean	Std. Dev.	Minimum	p25	p50	p75	Maximum
CC	654	0.345	0.554	0.012	0.156	0.672	0.899	0.961
Sindum	654	0.069	0.430	0	0	0	0	1
SIZE	654	10.167	1.221	5.506	10.453	12.221	13.434	20.989
IOS	654	3.675	5.345	0.003	0.435	0.877	2.121	5.129
Lev	654	0.465	0.234	0.175	0.223	0.343	0.445	0.878

Table 2. Correlation Matrix

	CC	Sindum	SIZE	IOS	Lev
CC	1				
Sindum	0.433	1			
SIZE	-0.165	-0.086	1		
IOS	0.485	0.022	-0.031	1	
Lev	0.312	0.187	-0.129	0.167	1

Table 2 shows the correlations between the variables. This matrix provides a context for understanding the potential effect of CC and Sindum. The moderate positive correlation between CC and Sindum (r = 0.433) suggests that sin stocks may have a higher cost of equity than non-sin stocks. This raises the question of whether this relationship is due to the perceived stigma of dealing in sin products or comes from the risks associated with these firms. SIZE shows a weak negative correlation with CC, which suggests firm size may vary slightly across sin and non-sin stocks but is not strongly related to the cost of equity, further hinting at the underlying heterogeneity across firms. The weaker negative correlation between Sindum and SIZE suggests that sin stocks tend to be smaller, which could partially explain their higher cost of equity. Meanwhile, IOS, which has a moderate positive correlation with CC, highlights that growth opportunities may also influence the cost of equity borne by the company, although there is almost no correlation between sin stocks and growth opportunities. In sum, the table shows evidence that there is no correlation between the independent variables.

With regard to model selection based on correlation data, the pattern implies that unobserved, time-invariant factors most likely play a role in determining the cost of equity and are correlated with sin stock status, making fixed effects a robust choice to control for such heterogeneity. By focusing on within-firm variation and removing the influence of unobserved, time-invariant factors, the fixed effects model ensures that the estimates of the relationship between Sindum and CC are not biased by omitted variables. This approach is particularly suitable given the structure of the correlations, which point to potential firm-specific unobservables that could affect the outcome. Thus, based on the correlation analysis, the fixed effects model is well-justified for accurately isolating the impact of sin stock status on the cost of equity.

Table 3 shows the mean difference between sin stocks and non-sin stocks for four variables: CC, SIZE, IOS, and Lev. The asterisks (*) indicate that the difference is statistically significant at the 0.05 level. Sin stocks have a significantly higher mean CC than non-sin stocks. This means that sin stocks are more likely to be classified as concentrated ownership firms. Non-sin stocks have a significantly higher mean SIZE than sin stocks. This implies that non-sin stocks are generally larger companies than sin stocks. Non-sin stocks have a significantly higher mean IOS than sin stocks. This signifies that non-sin stocks are generally more institutionalized than sin stocks. Sin stocks have a significantly higher mean Lev than non-sin stocks. This suggests that sin stocks generally have more debt financing than non-sin stocks.

These findings are consistent with previous research on sin stocks. For example, H. Hong and M. Kacperczyk [1] found that sin stocks in the United States exhibit a higher cost of equity compared to non-sin stocks. If stocks associated with sin activities exhibit a greater cost of capital compared to similar stocks, there is apparently a sin premium. Investors can capitalize on this sin premium if they are ready to disregard reputational risks [24]. This finding is attributed to the perceived social irresponsibility of sin stocks and their tendency to be undervalued by the market. A. Goss and G.S. Robert [16] also observed a similar pattern in the United States, with sin stocks favouring debt financing over equity financing. Sin stocks prefer private debt financing over equity financing because of a limited investor base resulting from societal norms [25]. The mean difference supports our hypothesis that, if a sin stock accesses funds through equity financing, it will be charged higher since investors perceive

it as a risky company. The investment opportunity set is also higher for non-sin stocks as they will have more options to access all the funding available. If a company has strong financial capabilities, it will have no problems using debt or even equity financing, as it will not have any difficulty convincing investors regarding its prospects.

Table 3. Mean difference between sin stocks and non-sin stocks

	Sin Stock	Non-Sin Stock	Difference
CC	0.878	0.557	0.332**
SIZE	4.334	10.848	-5.448*
IOS	0.198	3.334	-2.110**
Lev	0.419	0.154	0.114**

Hypothesis Testing

Table 4 displays the regression of Sindum to CC. The fixed effects model is justified based on the correlation matrix and the Hausman test, as well as the need to control for firm-specific characteristics. The patterns indicate that unobserved, time-invariant firm-specific factors, such as industry reputation or operational risk, are likely correlated with the explanatory variables, necessitating a fixed effects approach. The Hausman test further supports the use of a fixed effects model, with a test statistic of 15.84 ($p < 0.01$), rejecting the null hypothesis that random effects are appropriate. This result confirms that firm-specific effects are correlated with the explanatory variables, making fixed effects the more robust choice. By removing the influence of these unobserved, firm-specific factors, the fixed effects model isolates within-firm variation to provide unbiased estimates. This ensures that the observed effects of Sindum, SIZE, IOS, and LEV on CC reflect genuine within-firm dynamics rather than being confounded by static firm-level characteristics, making fixed effects the most methodologically sound approach.

The findings of this study, summarized in Table 4, provide compelling evidence for the hypothesis that sin stocks (tobacco and alcohol companies) face a higher cost of equity than non-sin stocks. This aligns with the theoretical arguments that sin stocks are perceived as less socially responsible and more likely to be undervalued by the market, leading to increased scrutiny from investors, the media, and the public. The results of the stepwise regression analysis further strengthen the robustness of the findings. We follow A. Goss and G.S. Robert [16] as well as A.M.L. Destri et al. [26], who study hypotheses in hierarchical order. We believe that this method helps to clarify the unique impact of sin stock status on cost of equity. With the help of a stepwise approach, hierarchical regression will allow us to observe the marginal effect caused by the inclusion of the control variables in the model, thus providing us with more robust explanations of the primary relationship.

In Model 2, the coefficient for Sindum is positive and significant, indicating that sin stocks do indeed have a higher cost of equity than non-sin stocks. This finding still holds after controlling for various factors that could affect the cost of capital in Model 3. The higher cost of equity for sin stocks can be attributed to several factors: sin stocks are often perceived as less socially responsible due to their association with harmful products such as alcohol and tobacco or are even as socially irresponsible by investors. This perception can lead to a reluctance to invest in these companies, resulting in a lower demand for their equity shares [26]. Additional research indicates that the returns on stocks are solely influenced by investors' preferences for non-sin stocks compared to sin stocks, as highlighted by S. Colonnello et al. [27]. This reduced demand, in turn, drives up the cost of equity for sin stocks as investors demand a higher premium to compensate for the perceived risk. Research by G. Nardella et al. [28] shows that firms that are perceived as hypocritical in their behaviour, claiming to deliver a higher value or standard than is really the case, will be "penalized" by their stakeholders with a higher required rate of return.

Table 4. Fixed Effect**:** Regression Results for Hypothesis Testing

	Model 1	Model 2	Model 3
Sindum		0.793**	0.325**
		(1.721)	(2.824)
Size	-0.004**		-0.455***
	(-3.242)		(-2.541)
IOS	-5.876**		3.655***
	(-10.91)		(-2.576)
LEV	0.145***		0.177***
	(0.223)		(8.334)

	Model 1	Model 2	Model 3
Constant	1.532	7.112	4.445
	(3.989)	(2.221)	(2.362)
Firm Dummy	Yes	Yes	Yes
Observation	654	654	654
Adj-R2	0.21	0.43	0.54

Note: t statistics in parentheses, *p<0.1, **p<0.05, ***p<0.01.

Sin stocks are often undervalued by the market due to the negative connotations surrounding their products and business activities. This undervaluation further exacerbates the higher cost of equity for sin stocks, as investors require a higher premium to compensate for the perceived lower value of their investments. Thus, sin stocks tend to favour debt financing over equity financing, a decision driven by the higher sensitivity of equity to social norms. Debt financing is less susceptible to social pressures and scrutiny compared to equity financing, which is more closely tied to a company's reputation and social responsibility. This preference for debt financing further contributes to the higher cost of equity for sin stocks.

The study introduces a new dimension to the understanding of sin stocks by focusing on a Muslim-majority context, where societal and regulatory pressures are intensified. While prior research in Western countries has emphasized undervaluation and resilience [29], the findings here suggest that these dynamics may not fully apply in Indonesia due to limited access to capital markets and stringent regulations. The implications of these findings extend beyond the realm of corporate finance into the domain of investment management. For corporate finance professionals, the higher cost of equity for sin stocks necessitates careful consideration of capital structure decisions. Sin stocks may need to explore alternative financing methods or consider strategic acquisitions to mitigate the impact of the higher cost of equity on overall financial health. For investment managers, these findings present both opportunities and challenges. On the one hand, the higher cost of equity associated with sin stocks may indicate a potential for higher returns, as investors are compensated for the perceived increased risk. However, investment managers must carefully weigh these potential returns against the elevated risk profile of sin stocks.

While the results confirm our hypothesis, they also reveal complexities. The inclusion of IOS in Model 3 highlights a nuanced interaction, where sin stocks appear less capable of leveraging growth opportunities compared to non-sin stocks. This finding was unexpected, as prior research in Western contexts often portrays sin stocks as resilient and undervalued growth opportunities. Instead, the Indonesian context shows that limited access to capital markets, combined with intense regulatory scrutiny, hampers the ability of sin stocks to capitalize on potential growth. Moreover, the use of a fixed effects model underscores the importance of controlling for unobserved, time-invariant firm-specific factors. These controls were critical in isolating the true effect of sin stock classification on the cost of equity, as the correlation matrix revealed potential confounding effects from firm size and leverage.

Prior research on the cost of equity for sin stocks is consistent with the findings of this study. For instance, H. Hong and M. Kacperczyk [1] found that sin stocks in the United States exhibit a higher cost of equity compared to non-sin stocks. This finding is attributed to the perceived social irresponsibility of sin stocks and their tendency to be undervalued by the market. A. Goss and G. S. Robert [16] also observed a similar pattern in the United States, with sin stocks favouring debt financing over equity financing. While companies classified as sin stocks are not operating illegally, they have a certain image of doing so. The result shows that there is a cost to being a sin stock. Others have shown that sin stocks have difficulty getting funding from equity [1].

These findings not only contribute to the broader literature on norm-based investments but also offer practical implications. For corporate finance, the higher cost of equity underscores the need for sin stocks to strategically manage their capital structures, potentially favouring debt financing to mitigate equity costs. For investment managers, these results highlight the potential for higher returns from sin stocks, albeit with elevated risks tied to societal perceptions and regulatory changes. By situating the findings within the specific cultural and regulatory context of Indonesia, this study expands the understanding of how social norms influence corporate financing decisions. Future research could further explore these dynamics across other Muslim-majority countries or regions with similar socio-cultural pressures, providing a more comprehensive view of the global implications of norm-based investing.

Conclusions

Theoretical contributions

Despite its valuable insights, this study also has limitations. Its sample is restricted to publicly traded companies in Indonesia from 2016 to 2020, potentially limiting the generalizability of the findings to other countries or time periods. Future research could expand the scope of the analysis to include a broader range of companies and time frames to enhance the understanding of the cost of equity for sin stocks across different contexts. In conclusion, the results of this study provide strong evidence to support the no-

tion that sin stocks face a higher cost of equity compared to non-sin stocks. This finding has significant implications for both corporate finance and investment management decisions. Further research could broaden the scope of analysis and delve deeper into the factors that influence the cost of equity for sin stocks in various contexts.

In this paper, we provide evidence for the impact of social norms, measured by sin stock status, on the cost of equity capital. The sin stocks examined here consist of Indonesian publicly traded companies involved in the production of alcohol and tobacco. We show that there is a significant difference in the mean value between sin stocks and non-sin stocks. Our paper has significant implications for the emerging literature on social norm-based investing. We examine whether norm-based investing affects how managers approach their sources of funds. Sin stocks are perceived differently by investors and creditors. Creditors tend to overlook whether a company's products are related to a vice activity. Their main issue is the company's financial capability to repay its debt. In contrast, investors are more sensitive to social norm issues: ultimately, they perceive a company involved in a vice activity as a risky investment and thus expect a higher rate of return.

Practical contributions

The findings of this study have critical policy implications and practical applications. For policymakers, the elevated cost of equity for sin stocks underscores the financial penalties tied to societal disapproval and regulatory pressures. Policymakers should aim to balance public health objectives with economic stability, considering strategies like implementing targeted education campaigns or incentivizing corporate social responsibility (CSR) initiatives to address societal concerns without disproportionately burdening these industries. For corporate managers, the results emphasize the need for enhanced transparency, robust CSR efforts, and potential diversification of operations to reduce dependency on sin-based revenues and mitigate reputational risks. For investors, the study highlights potential opportunities in sin stocks, which may offer higher returns for those willing to bear the associated risks of regulatory changes and societal disapproval. These insights emphasize the importance of tailoring financial policies and investment strategies to local socio-cultural realities, providing actionable guidance for stakeholders navigating the complexities of norm-based investing.

Limitations and future research opportunities

This study, while offering valuable insights, has several limitations. Geographically, the focus is limited to Indonesia, a predominantly Muslim-majority country, which may restrict the generalizability of the findings to other regions with differing socio-cultural and regulatory environments. Additionally, the relatively short time frame of analysis (2016–2020) may not fully capture long-term trends or the evolving influence of societal norms and regulatory frameworks for sin stocks. The industry coverage is also constrained to tobacco and alcohol, excluding other significant sin industries such as gaming or firearms, which limits the comprehensiveness of the findings. Furthermore, the binary classification of sin and non-sin stocks simplifies investor behaviour and does not consider varying intensities of societal disapproval across industries or among investors. Lastly, the reliance on publicly available financial data may overlook nuanced factors, such as the informal sector's role or the impact of smaller, unlisted companies.

Future research should expand the geographical scope to include other Muslim-majority countries or regions with distinct cultural contexts, enhancing the global relevance of the findings. Extending the analysis over a longer time frame could capture the long-term effects of societal norms and regulatory changes on sin stocks. Incorporating additional sin industries, such as gaming, firearms, or emerging sectors like cannabis and cryptocurrency, would provide a more holistic understanding of the phenomenon. Furthermore, studies focusing on investor sentiment through qualitative or survey-based data could shed light on how societal norms shape investment decisions. Research could also delve deeper into the regulatory impact by examining how specific measures, such as taxation or advertising bans, influence the cost of equity and financial performance of sin stocks. Finally, comparative studies between sin stocks and socially responsible investments, such as green or ESG-compliant firms, could offer valuable insights into the diverse effects of societal norms on financial metrics. These directions would enrich the understanding of the interplay between social norms, corporate finance, and investment behaviour across various contexts.

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Influence of ownership structure on the innovation activity of South Asian companies at different life cycle stages

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Abstract

The lack of understanding management of corporate and financial innovation management in South Asia raises the fear of the declining effects of new technologies. Therefore, it is of practical interest to compare the estimates of the impact of ownership concentration in different innovation-intensive industries to minimize the agency problem among managers and shareholders. The paper provides an econometric analysis using panel regression of model testing on companies from technologically sophisticated industries, such as the Heavy and Light Industry, Information Technology (IT), and Consumer Staples from South Asia in different life cycles stages from 2015 to 2020. The South Asian market is volatile and receptive to innovations, but R&D capacity in some countries remains low. The paper provides a better understanding of the relationship between the concentration of different forms of ownership and the intensity of innovation, using industry specifics and life cycle stages. It's known that institutional investors are still interested in developing new digital marketing channels by competing with industry "disruptors" due to the lack of necessary strength in the IT industry along with barriers to cross-border investment. The paper confirms a linear and inverted U-shaped relationship between different forms of ownership structure and innovation activity. The results allow focusing on industrial and cultural differences to avoid agency and resource conflicts for majority shareholders of the company to build effective corporate governance, achieving strategic goals and minimizing the risks of improper management decisions in R&D.

Keywords: life cycles, R&D, insiders, institutional investors, innovative activity, South Asia

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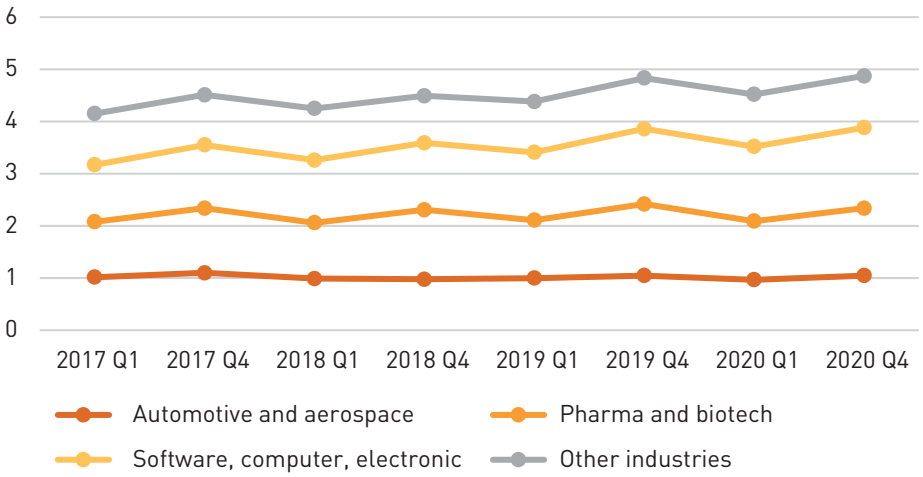
Introduction

Innovations are the head driver of both the growth intensity of developed and emerging economies and the market value of publicly traded companies. Companies focusing on developing new technologies have a higher market capitalization than traditional sector companies due to a higher potential for building competitive advantages in the future. However, global trends are also pushing companies in the traditional industries to compete with each other in piloting new products and changing management practices. For example, modern companies focus on developing the internal competencies of employees and transforming the organizational structure into a less hierarchical one to adapt faster to changes in the external environment. These conclusions were reached by [1] on data from American companies.

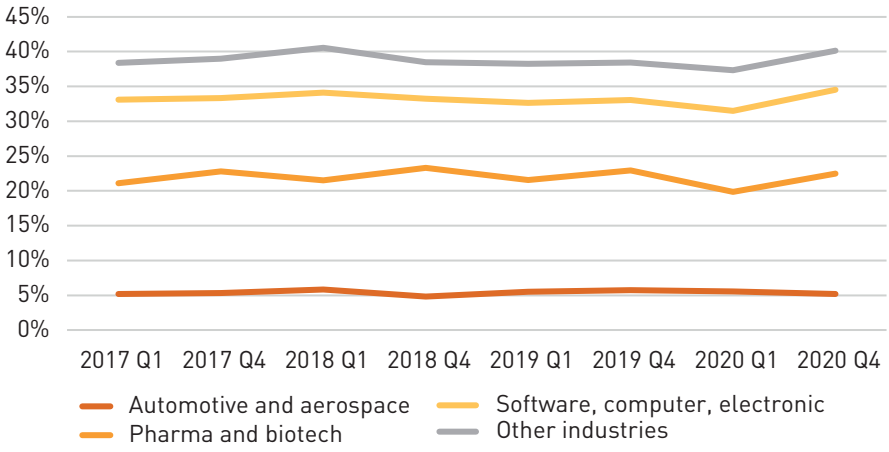
However, the intensity of innovation depends on the specifics of the industry and the level of technological development of a particular country. By section industry specifics, the main drivers of innovation regarding R&D investment are software, computers and their components (IT), pharmaceuticals and biotechnology, and automotive and aerospace. At the same time, other industries, including food processing and electrical engineering, have historically spent comparably less on R&D investments, as shown in Figure 1. On the other hand, for many technology industries, comparable levels of innovation intensity (R&D to revenue) have been sustained over the past four years and are less susceptible to business cycle fluctuations, as shown in Figure 2. For example, in the pharmaceutical and biotechnology sector, it is not possible to measure the effectiveness of a drug prior to clinical trials, so on average the relative R&D to revenue ratio for these industries is higher and reaches 16–18% over the historical period, which is less typical for the IT industry. Thus, the interest in studying the factors that influence the innovation rate is growing and persists to date.

Figure 1. R&D trend by industry group**.** Source: R&D trend in real terms extracted from OECD publications



Source: [2].

Figure 2. R&D intensity by industry group. Source: R&D intensity extracted from OECD publications



Source: [2].

The level of R&D investment varies across countries and companies at different life cycle stages which leads to higher productivity of R&D investment regardless of these differences, potentially producing misleading estimates and resulting conclusions, which may, in turn, cause sub-optimal R&D investment decisions at the firm's management level and have a generally negatively impact on their innovation and growth. Different levels of risk tolerance of shareholders and company management, motives and goals, and information asymmetry lead to the manager-shareholder agency problem. Agency theory suggests that increasing the share of internal and external owners is an effective mechanism for management to invest in R&D. However, the negative effect of insider ownership on innovation intensity may be greater that the positive effect of institutional ownership. Data from US multinational companies [3] demonstrates that insider ownership (insider ownership share) hurts innovation intensity. The presence of institutional investors strengthens the positive relationship between low managerial ownership and R&D expenditure but negatively affects the relationship between high managerial ownership and R&D expenditure.

R&D investment is calculated as a proxy indicator for different kinds of firm-level decisions [4], assuming that the activity of companies aimed at increasing productivity and building/maintaining competitive advantage favors such investments. However, the above statement can be rejected if the benefits outweigh the unfavorable outcomes of R&D investments because it does not guarantee positive effects. The future benefits of R&D investments are much more uncertain than other investments, such as capital expenditures [5; 6]. Although such investments may provide shareholders with higher returns, they negatively affect the firm's short-term financial performance and may only yield returns in the distant future. It is also necessary to consider the fact that the level of R&D investment varies across countries and firms at different stages of the life cycle [7]. An assumption of causality, i.e., R&D investment leading to higher productivity without accounting for these differences, which may yield misleading estimates and resulting conclusions. These uncertainties and the combination of the above factors may lead to suboptimal R&D investment decisions at the firm's management level and negatively affect their innovation and growth.

Different risk tolerance levels, and motives and goals of shareholders and company management, as well as information asymmetry lead to the manager and shareholder agency problem. The agency theory of the shareholder manager and the resource concept forms the theoretical justification for the presence of such a relationship. In particular, institutional investors and company management have conflicting interests because their time horizons differ [8]. The fiduciary responsibility of the former is to represent the long-term interests of their clients, and due to the high exit costs associated with significant investments, institutional investors develop long-term strategic relationships with the company. The concentration of ownership in the hands of certain types of shareholders affects the innovation activity of companies in different ways. In research, the impact of ownership concentration on innovation investment is mostly explained by agency theory, which states that there is a conflict of interest between owners and shareholders. Nevertheless, agency theory suggests that increasing the ratio of internal and external owners is an effective mechanism for management to make R&D investments. Due to this fact, there is still a debate in the literature regarding the form and direction of the influence of both insider and institutional ownership. For example, using the data from UK companies [9] showed that insider ownership has a non-linear relationship with innovation activity: small insider ownership has a positive relationship with innovation activity (logarithm of R&D expenditure), while greater insider ownership demonstrates a negative correlation, showing that companies in which the CEO or top management owns more shares produce fewer patents and focus on growth through mergers and acquisitions. A similar result on data from Chinese companies was found by [10], showing the negative impact of insider ownership and the positive impact of institutional ownership (ownership share of institutional investors) is translated with a 3-year lag. Also, Choi S. showed on data from companies in Korea that institutional ownership has a positive relationship with innovation activity.

The paper contributes to analyzing the impact of institutional and insider ownership concentration on investment in innovation activity of sector-specific South Asian companies at the growth and maturity stages. In the IT industry, innovations aim to improve the approbation of new technologies and finalize the existing ones. In the heavy and light industry sector, innovation activity is aimed to reduce costs of production technologies. There are marketing technologies and optimization of internal processes in the consumer staples industry. Investors favor more stable companies at the maturity stage, as their potential benefits increase with the investment horizon and the length of shareholding.

The expected results confirm that the most mobile resource for the formation of global financial capital for innovative development comprises the funds of institutional investors in free circulation in the economy, where the non-linear relationship between different forms of ownership structure and innovation activity can be resolved by the agent-based and resource-based theory, taking into account industry specifics and life cycle stages.

A more general question that this research aims to answer is whether the innovative activity of companies increases as a result of structuring the motives for managing ownership concentration, with regard to technological specifics. More specifically, the questions posed by this research are as follows:

1) How can different types of ownership concentration affect innovative activity by industry?
2) What are the main motives behind the influence of ownership concentration on innovation activity at the growth and maturity stages of the life cycle?

This research fills a scientific gap in the study of the impact of institutional and insider ownership concentration on investments in innovation activity of companies in South Asia from different industries in terms of technological complexity at the growth and maturity stages.

Related literature

The literature on the topic can be split into two main types. The first is devoted to the relationship between innovation activity, ownership structure, and financial company metrics. The present section of the research will help to determine the basic methodology.

The second section is a description of innovation activity and ways to measure it, along with a definition of the stages of a company's life cycle that will allow us to define the variables for the study.

Influence of ownership structure on innovative development and financial results of the company

Innovation activity is divided into two groups of indicators – Innovation input and Innovation output, where in case of the former the intensity of innovations shows how much the company is interested in innovation. Innovation input includes the group of indicators comprising the ratio of R&D to revenue, R&D to assets, and the ratio of NMA to assets. Innovation outputs can be measured, for example, by the number of patents and citation of patents.

Implementing innovation provides value for the company, and financial performance can be improved, so it is necessary to identify the determinants that influence innovation.

Innovation activity has a positive effect on the future growth of the company. Innovation activity, calculated as the ratio of R&D to assets with a lag of one year, is positively related to revenue growth in Korean pharmaceutical companies [11]. In addition to research, it has been demonstrated that an increase in R&D expenditure has a positive relationship with revenue growth and number of employees.

Also, innovation activity can be a signal for investors. Innovation intensity has a positive relationship with the company's market capitalization, return on assets, and return on equity. The positive relationship between innovation intensity was also shown by [12] on data from Chinese companies and by [13] on data from European companies. The concentration of ownership in the hands of certain types of shareholders affects firms' innovation activity in different ways. In previous studies, the effect of ownership concentration on innovation investment is related to agency theory, which states that there is a conflict of interest between owners and shareholders. H. Ahmed showed a non-linear relationship between innovation activity and insider ownership [9]. S. Choi demonstrated that institutional and foreign ownership has a positive relationship with innovation activity, while most of property ownership is retained by family shareholders, which leads to lower innovation intensity. The authors also concluded that private equity (private funds) can offset the risk aversion of family owners and stimulate R&D spending in firms. Analyzing data from public Spanish companies, [14] determined that concentration of family ownership has an inverse U-dependence: small family ownership increases firm innovation activity, while extended family ownership decreases it. As shown, institutional ownership positively affects a firm's innovation activity.

Studying the impact of corporate governance of US industrial companies that generate most of their revenues internationally on innovation intensity, used the percentage of shares owned by institutional investors and the percentage of voting shares owned by insiders to test the impact of institutional and insider ownership on innovation activity, which measured as the ratio of R&D to revenues [3]. For regression, the generalized least squares (GLS) method. The research results allow the authors to conclude that institutional ownership is insignificant and insider ownership hurts innovation intensity.

S. Choi also used the percentage of ownership by insiders and institutional investors to investigate the effect of ownership on the innovation activity of Chinese firms, which they calculated as the number of registered patents. Because of a problem of excessive variance in patent data in the authors' final sample, the authors concluded that there were necessary dynamics and unobserved cross-sectional heterogeneity in the analysis. It used negative binomial regression to account for such characteristics in the data. The results revealed that insider ownership negatively affects innovation activity with a lag of 3 years and institutional ownership positively with a lag of 3 years.

[16] used the percentage of insider and institutional (divided into bank and corporate ownership) ownership and squared these variables to estimate the effect of ownership on innovation intensity. The multilevel linear model was used to conduct this study.

According to the modeling results insider ownership was found to be insignificant, whereas corporate and banking ownership have a positive relationship on innovation intensity and have a U-shaped relationship.

H. Ahmed investigated the relation of corporate managers with the innovation activity of firms in the United Kingdom, calculated as the logarithm of R&D expenditures, using panel regression with fixed effects.

This variable in the square of the percentage of manager ownership was a proxy for insider ownership. It also used the variable in the square of the percentage by institutional investors. To test the authors' hypothesis that institutional investors have a moderating effect on managers (it was supposed that the percentage of managerial ownership hurts R&D expenditures), an iterative variable, the multiplication of the percentage of institutional investors by the percentage of managers and this variable squared, was introduced.

Results of the model revealed that managers' ownership share positively affects R&D, managers' squared ownership

share negatively affects R&D, institutional ownership share positively affects R&D, and the iterative variable of institutional and managerial ownership positively affects R&D. The authors conclude that the presence of institutional investors strengthens the positive relationship between low managerial ownership and R&D expenditure, but does not affect the negative relationship between high managerial ownership and R&D expenditure.

Assessment of the innovation activity of the company through the life cycle

To measure innovation production, the number of patent citations and the average number of citations per patent were used. These indicators allow us to study the effectiveness of innovation activity, which shows how much other scientists and researchers are interested in the company's scientific development. The same method was used by [17].

One of the main drivers of a company's competitiveness is investment in innovation. R&D results are the main driving force that affects financial performance and firm value. The benefits of R&D accumulate over the long term and have relatively uncertain benefits compared to capital expenditures, so managers need to understand how and when to maximize R&D benefits with limited resources.

Businesses at different stages of the LCR understand their advantages to maximize the benefits of innovation. For example, growing companies will spend more on capital expenditures to improve their competitive advantage, which positively affects the stock returns of such companies. The LCR includes growth, maturity, and stagnation stages. Firms in the growth stage focus on increasing revenues and assets to gain a competitive advantage. In the maturity stage, firms have steady sales growth, reduced R&D, and bureaucratic organizational structure. In the stagnation stage, firms are specialized by insufficient R&D expenditure and declining revenues. A company's R&D expenditure may vary depending on the stage of its life cycle. In the growth stage, firms focus on customer relationship management and new product development and therefore, invest a lot of cash in R&D. In the maturity stage, firms are most competitive. As firms pass through the maturity stage, they require more investment in R&D to accelerate innovation. When firms enter the stagnation stage, stable resource utilization weakens their innovation. At this stage, firms are no longer competitive and profitable, and they do not have sufficient resources for R&D.

[18] showed that revenue and capital expenditure growth is a function of the stages of the LCR. The authors categorized companies into groups based on the characteristics of the LCR and investigated the stock market reaction to changes in various financial indicators. Financial indicators, such as company age, dividend payout ratio, revenue growth, and capital expenditure to firm value ratio were used to categorize companies by stages of the LCR. This paper is divided into three sections according to stages of the LCR: growth, maturity, and stagnation. The unidimensional and multidimensional ranking were applied to determine the stage of the life cycle. For example, companies in the growth stage had low dividend payouts, high revenue growth, and capital expenditures and were young.

This method of determining the stage of the LCR was used by [19] when they investigated the effect of R&D contingencies on the companies' stock returns. The authors concluded that market reactions to increased R&D expenditures are the most negative in the maturity stage. The relationship between R&D and stock returns is non-linear and is influenced by the LCR.

It is worth noting that when Anthony J. and Ramesh K conducted their study of LCR, cash flow disclosure was not yet mandatory for US companies. In the work [20] cash flows (operating, investing, and financing) were used to determine the stages of LCR. This approach has advantages: firstly, it reflects all of the company's financial information rather than one group of indicators (such as company age and sales growth), secondly, it is periodic, indicating the true state of the business life cycle. Overall, Dickinson noted five main cycles of companies: introduction, growth, maturity, shake-out, and decline. Stages of the life cycle were determined based on the combination of signs (+/–) of the three cash flows.

Theory and hypotheses

Relationship between institutional ownership concentration and innovation intensity

A high concentration of institutional ownership has a positive *relationship with* **innovation intensity. In other words, if the coefficient estimates o**f the institutional ownership concentration variable are significant and with a positive sign, the null hypothesis is not rejected. Thus, the company's acquisition of deep knowledge of local markets, obtained as a result of the relationship with an institutional investor, levels out information asymmetry and helps to successfully invest in R&D and use competitive advantages at the international level.

H1: *A high degree of ownership concentration* on *institutional investors has a positive relationship with the intensity of innovation* structure [3].

Nevertheless, some empirical papers have found an inverse U-shaped relationship between different forms of institutional ownership structure, including financial, except banks, insurance institutions, and corporate investors. The theoretical justification is that up to a certain level institutional owners receive direct and indirect benefits from R&D investments: 1) profits from control and monitoring of managers introducing know-how products to the market; 2) equalization of bargaining power when institutional investors invest in another company; 3) risk sharing among the remaining shareholders, which exceeds the risk of the latter and the long-term payback horizon, but as ownership grows, risks become less diversified among

shareholders, as a consequence, preferences for risky R&D investments decrease, moving to the phase of a conservative investment program with a high payback guarantee. Low and moderate concentrations of institutional ownership will have a positive relationship with the intensity of innovation, but beyond a certain level, there will be a negative dependence [21].

H1.1: The high degree of ownership concentration among institutional investors has an inverse U-shaped dependence [16].

The relationship between insider ownership concentration and innovation intensity

According to agency theory, one way to monitor a manager's opportunistic behavior is to increase board members' ownership of the firm [22]. However, executives who are company managers (insiders) cannot monitor impartially because of the risk to their self-interest (for example, maintaining their current positions). Thus, it is assumed that the self-interest of insiders in short-term financial performance outweighs long-term, high-risk R&D investments. The concentration of ownership in the hands of insiders is assumed to hurt the intensity of innovation. In other words, if the coefficient of estimation of the insider ownership concentration variable is significant and with a negative sign, the null hypothesis is not rejected.

H2: *The high degree of concentration of ownership in the hands of insiders negatively affects the intensity of innovation* [3].

A low or moderate concentration of insider ownership has a positive relationship with R&D investment, but an inverse relationship occurs after a certain level. On the one hand, a restrained share of insider ownership can align the interests of shareholders and managers, reducing the opportunistic behavior of the latter as a result, stimulating investments with long-term and uncertain outcomes, such as R&D. However, it can be supposed that as the ownership of the company increases, the incentives for such innovations, including the emergence of incentives for self-interested motives, the reduction of unnecessarily risky investments, as a consequence of losses to their financial position, decrease due to the high rigidity of the manager. Thus, it suspects that there is an inverse U-shaped dependence between insider ownership and subsequent R&D investments.

H2.1: *A high degree of ownership concentration in the hands of insiders has an inverse U-shaped relationship* [16].

The relationship between ownership concentration and innovation intensity, and firm size

Company size plays an important role in assessing the impact of the concentration of different forms of ownership. Large companies have more prerequisites to be innovative compared to smaller companies. The theory suggests that R&D activities (called "creative destruction") is characterized by economies of scale: 1) R&D investment is a fixed cost and does not depend on the scale of production, which is confirmed by the ratio of gross domestic expenditure to R&D; 2) the risks of R&D investment can be better absorbed by large companies than by small companies; 3) large companies are more likely to benefit from the returns on R&D investment [23]. Thus, the effect of ownership concentration on innovation intensity is presumed to be more distinct in large companies. In other words, if the slope coefficient estimation for a variable is significant and greater than the coefficient estimation in hypotheses H1 or H2, the null hypothesis is not rejected.

H3: *Ownership concentration has a more* distinct *effect on innovation intensity in large companies.*

The effect of ownership concentration on innovation intensity as related to life cycle stages

The paper pays much attention to analyzing the impact of ownership concentration on innovation intensity at different life cycle stages. The researchers point out that during the growth stage, unstable consumer preferences and growing demand continue to stimulate the growth of product innovation intensity. During the transition to the maturity stage, products become more standardized, and companies compete in performance or efficiency. Innovation in product solutions is replaced by innovation in firm processes, focusing on managerial best practices. Nevertheless, there is no convincing empirical work that confirms that innovation activity is less in the maturity stage than in the growth stage.

The relationship between different forms of ownership and innovation as a company moves through life cycle stages is poorly understood [24] despite extensive research on the impact of corporate governance components on innovation activity [25–28]. In particular, Cucculelli M. and Peruzzi V. test multidirectional hypotheses about the impact of institutional ownership on innovation activity at the maturity stage: 1) at the maturity stage, institutional owners have a short planning horizon and expect a return on their investment through short-term financial results [29]. Thus, the probability of investing in R&D is lower than in the growth stage; 2) since financially controlled firms have better performance and management practices than other firms [30], they may be more able to identify growth opportunities arising from investment in innovation, even during maturity. Thus, a hypothesis has been formulated based on the second assumption.

H4: *The impact of institutional ownership concentration increases from the growth stage to the maturity stage.*

The effect of ownership concentration on innovation intensity concerning the industry specifics

Of particular interest is the comparison of estimates of the impact of ownership concentration in different innovation-intensive industries. Previous works implicitly esti-

mated the impact of insider (in the person of the company's management) ownership depending on the innovation intensity of an individual company rather than the industry as a whole. Managerial ownership positively affects R&D expenditure in firms with low R&D intensity [9], but negatively in German firms with high R&D intensity. In this paper, it is supposed that a high concentration of some ownership in industries with high innovation intensity, such as the IT industry, has a distinct impact since R&D investments in this case are the prerogative of their further development. Thus, the level of innovation intensity in high-tech industries is established using the determinants of corporate governance, namely the level of institutional and insider ownership concentration, the characteristics of top management, and the composition of the board of directors. Thus, the hypothesis tested the proposition that the effect of ownership concentration is distinct and more significant in industries with high innovation intensity compared to industries with low intensity.

H5: *Ownership concentration has a much more distinct influence in industries with high innovation intensity.*

Data and Methods

Data

Providing an assessment of the effect of innovation intensity on the capital structure of Southeast Asian companies, the paper examines the relationship of corporate governance with companies that generate most of their revenue in the international market using the percentage of shares held by institutional investors as well as the percentage of voting shares held by insiders [3]. The main criterion for collecting data from the largest developed economies is the fact that these regions have a high concentration of large technology companies that invest heavily in R&D. The high heterogeneity of companies by sector and stage of the life cycle allows us to analyze the impact of variables on the total sample at different levels of detail in Table 1: 1) high-tech companies (high and medium-high technology firms) at the stage of growth and maturity; 2) low-tech companies (medium, medium-low, and low technology firms) at the stage of growth and maturity.

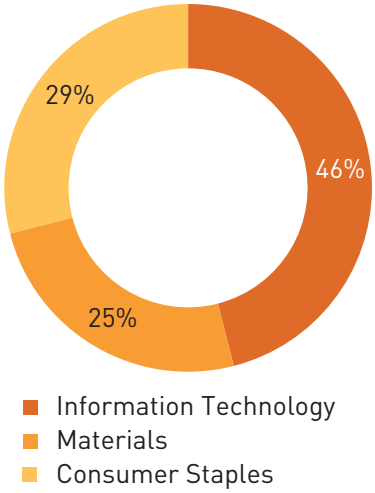
Table 1. OECD taxonomy of economic activities based on R&D intensity

	Manufacturing	R&D as % of GVA[2]	Non-manufacturing	R&D as % of GVA[2]
High R&D intensity industries	303[1]: Air and spacecraft and related machinery	31.69	72: Scientific research and development	30.39
	21: Pharmaceuticals	27.98	582[1]: Software publishing	28.94
	26: Computer, electronic and optical products	24.05		
Medium-high R&D intensity industries	252[1]: Weapons and ammunition	18.87	62-63: IT and other information services	5.92
	29: Motor vehicles, trailers and semi-trailers	15.36		
	325[1]: Medical and dental instruments	9.29		
	28: Machinery and equipment n.e.c.	7.89		
	20: Chemicals and chemical products	6.52		
	27: Electrical equipment	6.22		
	30X[1]: Railroad, military vehicles and transport n.e.c. (ISIC 302, 304 and 309)	5.72		
Medium R&D intensity industries	22: Rubber and plastic products	3.58		
	301[1]: Building of ships and boats	2.99		
	32X[1]: Other manufacturing except medical and dental instruments (ISIC 32 less 325)	2.85		
	23: Other non-metallic mineral products	2.24		
	24: Basic metals	2.07		
	33: Repair and installation of machinery and equipment	1.93		
Medium-low R&D intensity industries	13: Textiles	1.73	69-75X: Professional, scientific and technical activities except scientific R&D (ISIC 69 to 75 less 72)	1.76
	15: Leather and related products	1.65	61: Telecommunications	1.45
	17: Paper and paper products	1.58	05-09: Mining and quarrying	0.80
	10-12: Food products, beverages and tobacco	1.44	581[1]: Publishing of books and periodicals	0.57
	14: Wearing apparel	1.40		
	25X[1]: Fabricated metal products except weapons and ammunition (ISIC 25 less 252)	1.19		
	19: Coke and refined petroleum products	1.17		
	31: Furniture	1.17		
	16: Wood and products of wood and cork	0.70		
	18: Printing and reproduction of recorded media	0.67		
Low R&D intensity industries			64-66: Financial and insurance activities	0.38
			35-39: Electricity, gas and water supply, waste management and remediation	0.35
			59-60: Audiovisual and broadcasting activities	0.32
			45-47: Wholesale and retail trade	0.28
			01-03: Agriculture, forestry and fishing	0.27
			41-43: Construction	0.21
			77-82: Administrative and support service activities	0.18
			90-99: Arts, entertainment, repair of household goods and other services	0.11
			49-53: Transportation and storage	0.08
			55-56: Accommodation and food service activities	0.02
			68: Real estate activities	0.01

Source: [31].

The data was obtained from the following information sources: Bloomberg, Thomson Reuters, and Capital IQ. Data includes information on the company balance sheet structure (total assets and total debt), revenues and expenses (revenue, EBITDA, and net income), cash flows (total operating, investing, and financing flows, R&D investments), shareholder structure (shares of institutional investors and insiders) and general information (GICS industry affiliation in Figure 3) from 2015 to 2020. To improve the accuracy of the analysis, companies with significant omissions, some of which were delisted from the stock exchange during the study period or lost their public company status and were involved in a merger transaction during the study period, were excluded from the dataset. Statistical data includes 3242 companies (over six years) that invested in R&D over the entire study period from 2015 to 2020.

Figure 3. Distribution of companies by industry. Source: Author's own calculations and elaborations



The disaggregation of the sample at the level of each industry reduces right-sided asymmetry and heterogeneity; however, it is also present within each industry group, but to a lesser extent.

The data includes information about the companies' balance sheet structure (total assets and total debt), revenues and expenses (revenue, EBITDA, and net income), cash flows (total operating, investment, and financing flows, R&D investments), shareholder structure (shares of institutional investors and insiders). Proxy variables, such as the percentage of stock ownership by institutional investors (INST) and the percentage of stock ownership by insiders (INSD) of ownership structure, were used for the analysis. The research used panel regression characterized by Generalized Least Squares (GLS) method with random effects and cluster errors. The analysis and estimation were conducted using two models, one analyzed using linear regression and the other – using negative binomial regression. The random effects model assumes that the unobserved characteristics of the companies in the sample vary randomly. Moreover, this model allows for the inclusion of time-invariant variables, unlike the fixed effects model, which excludes them through the differentiation process. It is reasonable to expect that the differences between companies do affect innovation activity, so the random effect model should be more robust. Three indicators were used as control variables, one of which is company size (SIZE), calculated through the logarithm of assets and characterizing economies of scale, as well as accumulated resources for greater involvement in innovation activity. Leverage (LVG) affects the innovation activity of companies by regulating R&D expenditures and controlling financial constraints that may reduce the intensity of innovation. Profitability (EBTD_MRGN) is also used as a control variable and calculated as the net income ratio to assets. Profitability is assumed to have a positive relationship with innovation activity because more profitable companies have more funds to spend on innovation activities [32].

Measures

Descriptive statistics of the total sample of unbalanced panel data are presented in Table 2. The data have high heterogeneity in financial and non-financial indicators. In particular, the average values of innovation intensity (R&D_NS), ownership concentration, and financial indicators are significantly higher than the median values, which means a right-sided distribution asymmetry. Another level of sample detail implies the division of companies by life cycle stages. In particular, at the maturity stage, companies demonstrate a higher level of innovation intensity than at the growth stage, which is consistent with the methodology. In addition, the average size of such companies (T_ASSETS) is on average larger and the level of ownership concentration is also higher than at the earlier stage.

Table 2. Descriptive statistics at different stages of the life cycle for the total sample

Life cycle stage		R&D_NS	INST	INSD	LVG	EBT_MRGN	T_ASSETS	SIZE
Growth	N	5 171	5 171	4 184	5 171	5 171	5 171	5 171
	Mean	3.8	30.0	8.4	1.1	12.2	2 232	6.0
	SD	6.1	23.9	12.4	5.3	9.5	11 789	1.7
	p25	0.7	10.7	0.5	0.0	6.3	130	4.9
	p50	1.8	24.7	3.0	0.1	9.8	335	5.8
	p75	4.4	44.1	10.8	0.5	14.8	1 129	7.0

Life cycle stage		R&D_NS	INST	INSD	LVG	EBT_MRGN	T_ASSETS	SIZE
Maturity	N	5 418	5 418	4 315	5 418	5 418	5 418	5 418
	Mean	5.0	35.0	9.6	1.4	13.8	5 691	6.4
	SD	6.5	29.3	13.5	5.3	10.3	19 856	2.1
	p25	0.8	9.5	0.4	0.0	6.7	121	4.8
	p50	2.5	26.3	3.5	0.3	11.8	389	6.0
	p75	6.7	56.3	14.0	1.0	18.0	2 450	7.8
Total	N	10 589	10 589	8 499	10 589	10 589	10 589	10 589
	Mean	4.4	32.6	9.0	1.3	13.0	4 002	6.2
	SD	6.3	26.9	13.0	5.3	9.9	16 509	1.9
	p25	0.7	10.2	0.5	0.0	6.5	125	4.8
	p50	2.1	25.4	3.2	0.1	10.6	357	5.9
	p75	5.2	49.8	12.5	0.8	16.5	1 569	7.4

Source: Author's own calculations and elaborations.

A comparative analysis of industries in Tables 3–5 indicates that the average innovation intensity is higher in IT than in heavy and light industries and the consumer sector, which is also in line with the OECD classification. In terms of ownership structure, the average share of institutional investors is higher in the consumer and industrial sectors, which is not the case for the IT industry. However, it is assumed that the relationship between ownership concentration and innovation intensity is positive.

Table 3. Descriptive statistics at different stages of the life cycle for Consumer Staples industry

Life cycle stage		R&D_NS	INST	INSD	LVG	EBT_MRGN	T_ASSETS	SIZE
Growth	N	845	845	668	845	845	845	845
	Mean	1.4	29.8	10.0	0.9	10.4	2 303	6.2
	SD	3.4	22.4	15.1	2.9	7.9	9 448	1.6
	p25	0.4	12.4	0.4	0.0	5.5	165	5.1
	p50	0.8	25.6	1.9	0.1	8.1	487	6.2
	p75	1.4	41.3	14.1	0.4	13.0	1 659	7.4
Maturity	N	873	873	683	873	873	873	873
	Mean	1.5	42.9	6.7	1.7	14.1	11 263	7.3
	SD	2.3	28.8	12.1	6.6	9.9	28 750	2.2
	p25	0.4	17.3	0.2	0.1	6.7	237	5.5
	p50	0.9	37.9	0.8	0.5	12.5	1 286	7.2
	p75	1.7	69.9	5.9	1.4	18.8	7 918	9.0
Total	N	1 718	1 718	1 351	1 718	1 718	1 718	1 718
	Mean	1.4	36.4	8.3	1.3	12.3	6 856	6.8
	SD	2.9	26.6	13.8	5.1	9.1	21 994	2.0
	p25	0.4	14.8	0.3	0.0	5.9	197	5.3
	p50	0.8	30.0	1.5	0.2	9.8	759	6.6
	p75	1.5	55.1	10.2	1.0	16.8	3 362	8.1

Source: Author's own calculations and elaborations.

On the other hand, the IT industry is characterized by a higher proportion of insiders in the ownership structure, which is also consistent with the theory that low to moderate concentration of insider ownership has a positive relationship with R&D investment. The comparative characterization of firms in different industries at different life cycle stages allows us to track innovation intensities (R&D_NS) and changes in ownership structure during the transition from growth to maturity stage. In the consumer sector, firms tend to maintain a stable level of innovation intensity when moving to the late stage, however, the concentration of institutional investors increased on average across the sample, while the share of insiders decreased on the contrary. Financial indicators (LVG, EBT_MRGN, T_ASSETS) of mature companies grew on average, which is also consistent with the life cycle theory, companies on average become larger with sustainable competitive advantages, which allows for high EBITDA margins for shareholders. At the IT maturity stage, companies in the 75% percentile tend to increase their innovation intensity, for these companies the concentration of institutional shareholders and insiders is higher on average. In the remaining cases, the level of innovation intensity does not change significantly when moving to the maturity stage.

Table 4. Descriptive statistics at different stages of the life cycle for Information Technology industry

Life cycle stage		R&D_NS	INST	INSD	LVG	EBT_MRGN	T_ASSETS	SIZE
Growth	N	2 620	2 620	2 139	2 620	2 620	2 620	2 620
	Mean	6.0	27.7	9.8	1.7	12.8	1 848	5.5
	SD	7.6	24.6	12.2	6.9	10.5	14 322	1.6
	p25	1.5	8.2	1.1	0.0	6.2	91	4.5
	p50	3.7	20.0	5.0	0.1	10.2	213	5.4
	p75	7.5	40.7	13.9	0.8	16.0	602	6.4
Maturity	N	3 273	3 273	2 660	3 273	3 273	3 273	3 273
	Mean	7.0	30.9	10.5	1.7	13.6	3 930	5.8
	SD	7.4	28.6	13.3	5.6	10.9	18 418	1.9
	p25	1.9	7.3	1.2	0.0	6.1	96	4.6
	p50	4.5	21.1	5.1	0.3	11.0	223	5.4
	p75	9.7	47.7	15.4	1.2	17.9	931	6.8
Total	N	5 893	5 893	4 799	5 893	5 893	5 893	5 893
	Mean	6.6	29.5	10.2	1.7	13.3	3 004	5.7
	SD	7.5	26.9	12.8	6.2	10.7	16 752	1.8
	p25	1.7	7.7	1.2	0.0	6.2	93	4.5
	p50	4.1	20.6	5.1	0.2	10.6	217	5.4
	p75	8.6	44.6	14.9	1.0	16.9	758	6.6

Source: Author's own calculations and elaborations.

Companies from the industrial sector are characterized by an increase in institutional and insider ownership as they move to a later stage, but the level of innovation intensity does not change significantly between stages. Thus, the consumer and industrial sectors have a higher concentration of institutional investors at the maturity stage with relatively stable levels of innovation intensity. However, the share of insiders is higher only in the industrial sector. In the IT sector, companies with a high concentration of institutional and insider ownership have a higher intensity of innovation when moving to the maturity stage, while the level of ownership is much lower than in other industries.

Table 5. Descriptive statistics at different stages of the life cycle for Materials industry

Life cycle stage		R&D_NS	INST	INSD	LVG	EBT_MRGN	T_ASSETS	SIZE
Growth	N	1 706	1 706	1 377	1 706	1 706	1 706	1 706
	Mean	1.8	33.8	5.4	0.4	12.0	2 786	6.6
	SD	2.4	23.2	10.6	2.3	8.5	7 849	1.5
	p25	0.5	15.3	0.2	0.0	6.9	226	5.4
	p50	1.2	29.8	0.9	0.1	10.0	592	6.4
	p75	2.5	48.4	4.6	0.2	14.2	1 911	7.6
Maturity	N	1 272	1 272	972	1 272	1 272	1 272	1 272
	Mean	2.1	40.1	9.0	0.6	14.0	6 400	7.1
	SD	2.7	29.6	14.6	2.6	8.9	14 497	2.0
	p25	0.5	13.1	0.2	0.0	8.4	267	5.6
	p50	1.2	36.3	1.0	0.1	12.9	1 097	7.0
	p75	2.8	62.8	12.9	0.6	17.5	5 666	8.6
Total	N	2 978	2 978	2 349	2 978	2 978	2 978	2 978
	Mean	1.9	36.5	6.9	0.5	12.9	4 329	6.8
	SD	2.5	26.3	12.5	2.4	8.7	11 323	1.8
	p25	0.5	14.4	0.2	0.0	7.4	246	5.5
	p50	1.2	31.4	0.9	0.1	11.1	725	6.6
	p75	2.6	54.4	6.6	0.3	15.8	3 029	8.0

Source: Author's own calculations and elaborations.

Table 6 presents the correlation matrix of the variables used in the regression analysis.

Table 6. Correlation matrix

	R&D_NS	INST	InsD	LVG	EBTD_MRGN	SIZE
R&D_NS	1.00					
INST	0.11	1.00				
InsD	0.05	–0.35	1.00			
LVG	0.13	0.09	0.01	1.00		
EBTD_MRGN	0.15	0.21	0.02	0.04	1.00	
SIZE	–0.13	0.54	–0.31	–0.02	0.22	1.00

Source: Author's own calculations and elaborations.

There is no significant correlation between the variables (correlation does not exceed 60%) nevertheless, a positive correlation between the share of institutional investors (INST) and the logarithm of total company assets (SIZE), close to the threshold value, should be stated. There is no correlation above the threshold value of 60%, which allows us to reject the problem of multicollinearity between the variables.

Econometric model

The paper is based on the regression methodology and statistical analysis of panel data where clustered standard error models are applied. Negative binomial regression should also be used in econometric analysis with unobserved cross-sectional heterogeneity to avoid the problem of excessive data variance. The econometric model is analyzed using the sample presented in Fig. 5 at different levels of detail.

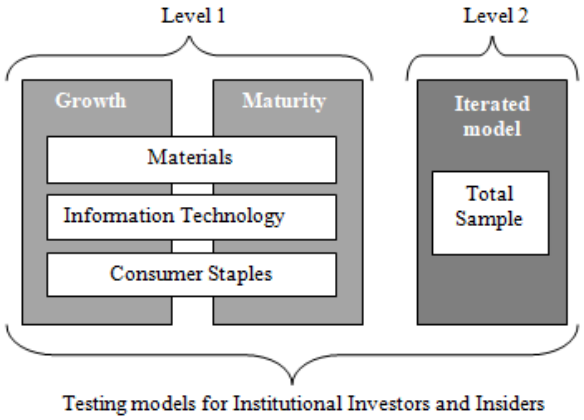
The first level involves identifying the life cycle stage, at which the hypotheses are tested. The company cash flow approach is often used to determine the stages of the life cycle. In contrast to other approaches that measure the life cycle through the age of the company, the cash flow ap-

proach, according to Dickinson V. is a full-fledged proxy, covering the investment process. Dickinson is a full-fledged proxy, simultaneously covering investment policy, profitability, growth rate, and risks at the company level. Thus, the life cycle stages were defined through operating cash flow (OCF), investment cash flow (ICF), and financial cash flow (FCF) [20]. For analysis, the two most active stages of the life cycle of technological innovations – growth and maturity – are taken into account, and calculated according to the following methodology:

1) The Growth stage, if OCF >0; ICF <0; FCF >0;
2) The Maturity stage, if OCF >0; ICF <0; FCF <0.

At the second level, the analysis of model testing at different levels of sample granularity is carried out, where the first level of granularity involves testing hypotheses about the linear and non-linear relationships between ownership concentration and innovation intensity at the stages of the life cycle: growth and maturity, and the second – models with iterative variables.

Figure 4. Breakdown of the total sample



Source: Author's own calculations and elaborations.

The concentration of ownership in the hands of institutional investors was used as an estimate of ownership concentration in private investors' hands, and the ownership in the hands of insiders was used as an estimate of the share in the hands of insiders. These variables are explanatory in the model. Studying internal factors and identifying significant dependencies allows companies to effectively restructure their corporate governance system to further increase the economic potential and reallocate available resources to invest in R&D. Below is the specification of the regression model with linear dependence for institutional investors:

$$\frac{R\&D}{NS_{i,t}} = \beta_0 + \beta_1 INST_{i,t} + \beta_2 LVG_{i,t} + \\ + \beta_3 EBTD\_MRGN_{i,t} + \beta_4 SIZE_{i,t} + \varepsilon_{i,t}, \quad (1)$$

where $\frac{R\&D}{NS_{i,t}}$ – R&D to Net Sales;

$INST_{i,t}$ – ownership concentration of institutional investors; $EBTD\_MRGN_{i,t}$ – EBITDA profit margin;

$SIZE_{i,t}$ – logarithm of total assets;

$ù_{i,t}$ – financial leverage.

A model with linear dependence for insiders was also tested:

$$\frac{R\&D}{NS_{i,t}} = \_0 + \_1 INSD_{i,t} + \_2 LVG_{i,t} + \\ + \_3 EBTD\_MRGN_{i,t} + \_4 SIZE_{i,t} + \_i,t, \quad (2)$$

where $\frac{R\&D}{NS_{i,t}}$ – R&D to Net Sales;

$INSD_{i,t}$ – ownership concentration of insiders;

$EBTD\_MRGN_{i,t}$ – EBITDA profit margin;

$SIZE_{i,t}$ – logarithm of total assets;

$ù_{i,t}$ – financial leverage.

The following variables were used as control variables.

Size of the company:

$$\mathrm{SIZE} = \mathrm{LN}(\mathrm{T\_ASSETS}). \quad (3)$$

Financial leverage:

$$\mathrm{LVG} = \frac{Debt}{Equity}. \quad (4)$$

EBITDA profit margin:

$$EBTD_{MRGN} = \frac{EBITDA}{REVENUE} \cdot 100\%. \quad (5)$$

Next, the shareholder ownership structure at different stages of the life cycle was assessed using quadratic dependence. Building on the methodology of the paper, a U-shaped test was used to test the non-linear relationship between R&D investment between the variables.

The specifications of the regression models with quadratic dependence are summarized below.

For institutional investors:

$$\frac{R\&D}{NS_{i,t}} = \_0 + \_1 INST_{i,t} + \_2 SQUINST_{i,t} + \\ + \beta_3 LVG_{i,t} + \beta_4 EBTD\_MRGN_{i,t} + \beta_5 SIZE_{i,t} + \varepsilon_{i,t}, \quad (6)$$

where $\frac{R\&D}{NS_{i,t}}$ – R&D to Net Sales;

$INST_{i,t}$ – ownership concentration of institutional investors;

$SQUINST_{i,t}$ – ownership concentration of institutional investors squared;

$ù_{i,t}$ – financial leverage; $EBTD\_MRGN_{i,t}$ – EBITDA profit margin; $SIZE_{i,t}$ – logarithm of total assets.

For insiders:

$$\frac{R\&D}{NS_{i,t}} = \beta_0 + \beta_1 INSD_{i,t} + \beta_2 SQUINSD_{i,t} + \beta_3 LVG_{i,t} + \\ + \beta_4 EBTD_{MRGN_{i,t}} + \beta_5 SIZE_{i,t} + \varepsilon_{i,t}, \quad (7)$$

where $\frac{R\&D}{NS_{i,t}}$ – R&D to Net Sales;

$INSD_{i,t}$ – ownership concentration of insiders; $SQUINSD_{i,t}$ – ownership concentration of insiders squared; $ù_{i,t}$ – financial leverage; $EBTD\_MRGN_{i,t}$ – EBITDA profit margin; $SIZE_{i,t}$ – logarithm of total assets.

Institutional investors and insiders are motivated to spend more on R&D to secure greater long-term financial returns. However, when ownership in a firm increases to a level where owners perceive R&D expenditures as a high risk to their portfolio, R&D expenditures begin to jeopardize savings and as a consequence may lead to the deterioration in the economic potential of the firm. As a result, institutional investors and insiders do not support the additional fundraising initiative, contributing to the reduction of R&D investment. The variables described in formulas (3)–(5) were used as control variables.

A model specification was also used where iterated variables for insiders and institutional investors were used as the main explanatory variables, the specification of this model is shown below.

For insiders:

$$\frac{R\&D}{NS_{i,t}} = \beta_0 + \beta_1 INSDSIZE_{i,t} + \beta_2 LVG_{i,t} + \beta_3 EBTD_{MRGN_{i,t}} + \beta_4 LNREV_{i,t} + \varepsilon_{i,t}, \quad (8)$$

where $\frac{R\&D}{NS_{i,t}}$ – R&D to Net Sales;

$ù_{i,t}$ – financial leverage; $EBTD\_MRGN_{i,t}$ – EBITDA profit margin; $LNREV_{i,t}$ – logarithm of revenue; $INSDSIZE_{i,t}$ – multiplying of the average of all company assets by the share of stock ownership of insiders.

For institutional investors:

$$\frac{R\&D}{NS_{i,t}} = \beta_0 + \beta_1 INSTSIZE_{i,t} + \beta_2 LVG_{i,t} + \beta_3 EBTD_{MRGN_{i,t}} + \beta_4 LNREV_{i,t} + \varepsilon_{i,t}, \quad (9)$$

where $\frac{R\&D}{NS_{i,t}}$ – R&D to Net Sales;

$ù_{i,t}$ – financial leverage; $EBTD\_MRGN_{i,t}$ – EBITDA profit margin; $LNREV_{i,t}$ – logarithm of revenue; $INSTSIZE_{i,t}$ – multiplication of the average of all company assets by the share of stock ownership of institutional investors.

The variables described by formulas 3, 4 and 5 and the logarithm of revenue described by formula 10, were used as control variables:

$$\mathrm{LNREV} = \mathrm{LN}(\mathrm{REVENUE}). \quad (10)$$

It is assumed that the larger the firm, the higher the intensity of the effect of ownership concentration on innovation.

The companies in the sample have a specific and time-invariant nature, due to the fact that the fixed effects model was chosen. It is considered fixed because it does not affect the dynamics of the behavior of the dependent variable and refers only to the difference between the firms themselves. In contrast, the random effects model assumes that the unobserved characteristics of the firms in the sample change randomly. Moreover, this model allows for the inclusion of time-invariant variables, unlike the fixed effects model, which excludes them through the differentiation process. It is reasonable to expect that differences between firms do affect innovation activity, thus the random effects model should be more robust.

All appropriate checks related to the characteristics of the data should be performed in a regression model with a linear dependence on the total sample before discussing the empirical results.

The heteroscedasticity problem was tested using the Wald test in a fixed effect model, and the p-value was zero, so the homoscedasticity null hypothesis was rejected. An example of a heteroscedasticity test is presented below in Table 7.

Table 7. The Wald test for heteroscedasticity

Chi2	1.5E+38
P-value	0

Source: Author's own calculations and elaborations.

The Wooldridge test for the presence of autocorrelation was used to detect the presence of serial correlation. Since the p-value is 0 in Table 8, the null hypothesis of no autocorrelation is rejected. Cluster standard errors are used to check the heteroscedasticity and autocorrelation in the models. Such standard errors allow for larger confidence intervals because they relax the assumption of correlation between observations, which helps to avoid selecting significant variables that are insignificant.

Table 8. The Wooldridge test for autocorrelation

F (1.2121)	15.907
P-value	0

Source: Author's own calculations and elaborations.

Next, tests show which model specifications (fixed or random effects) are preferred. Using the Lagrange multiplier of the Breusch-Pagan test in Table 9, the significance of the random effects model was shown. Rejection of the null hypothesis means there is a significant difference between the companies, and ordinary OLS regression is not appropriate.

Table 9. The Breusch-Pagan test for Lagrange multiplier

Estimated results	Var	SD
RD_Sales	0.0212736	0.1458548
e	0.0057741	0.0759873
u	0.0257476	0.1604607
Chi2	6775.72	
P-value	0	

Source: Author's own calculations and elaborations.

The Hausman test compared fixed and random effects models. According to the results of the Hausman test in Table 10, the model with random effects is preferable.

Table 10. The Hausman test to verify model specifications

Chi(9)	10.25
P-value	0.33

Source: Author's own calculations and elaborations.

The paper will use panel regression (generalized least squares method) with random effects with cluster errors.

Results

R&D investments contribute to long-term company development, but the costs can also affect income in the short term. It is taking to be that all investors are more involved in monitoring the company management and interested in long-term development respectively. Model testing results are with cleaning of the sample from outliers and omissions in Tables 11–13.

Table 11. Empirical results of regression on the impact of ownership structure on innovative activity for Information Technology industry

Model	Linear model			Iterative model		Quadratic model
Life Cycle	General	Growth	Mature	General		General
Variables	R&D to NS	R&D to NS	R&D to NS	R&D to NS	R&D to NS	R&D to NS
INST	0.0367***	0.0283***	0.0416***			–0.00841
	(0.00443)	(0.00699)	(0.00564)			(0.0109)
SQUINST						0.000529***
						(0.000116)
LVG	0.0298***	0.0185	0.0419***	0.0308***	0.00408	0.0306***
	(0.00941)	(0.0139)	(0.0126)	(0.00939)	(0.00947)	(0.00940)
EBTD MRGN	–0.0198**	0.0620***	–0.0746***	–0.0205**	–0.0139	–0.0193**
	(0.00903)	(0.0153)	(0.0110)	(0.00902)	(0.00892)	(0.00902)
SIZE	–0.790***	–1.289***	–0.434***	–0.957***	–0.480***	–0.784***
	(0.101)	(0.165)	(0.127)	(0.106)	(0.107)	(0.101)
INSTSIZE				0.0299***		
				(0.00316)		
INSDSIZE					-0.0235***	
					(0.00804)	
Constant	9.592***	11.03***	8.421***	10.47***	10.36***	9.990***
	(0.556)	(0.893)	(0.708)	(0.569)	(0.633)	(0.562)
R^2	0.510	0.381	0.285	0.221	0.189	0.525
Obs	5893	2620	3273	5893	5893	5893
Number of Tickers	1750	800	950	1750	1750	1750

Standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1.

Source: Author's own calculations and elaborations.

Hypothesis 1 about the positive impact of institutional ownership on innovation intensity is not rejected in the IT industry at all stages of the life cycle, and in all industries at the growth stage, but is rejected in the consumer sector. That is because the share of institutional investors in the consumer sector and light and heavy industry sector is more than 35%, while in the IT industry it comprises less than 30%, however, despite the relatively small share, investors are concerned with overcoming corporate problems to normalize and maximize the company's economic performance exclusively in the long run. The low share of institutional investors in the IT industry also acts as a deterrent to absorbing the managerial ambitions of minority shareholders that inhibit the decision-making process in companies. The results for the IT sector have been confirmed in studies of [3].

Table 12. Empirical results of regression on the impact of ownership structure on innovative activity for Consumer Staples industry

Model	Linear model			Quadratic model		Iterative model
Life Cycle	General	Growth	Mature	Growth	Mature	General
Variables	R&D to NS	R&D to NS	R&D to NS	R&D to NS	R&D to NS	R&D to NS
INSD	–0.0110	–0.00207	–0.0445***	–0.00135	0.0651**	
	(0.00861)	(0.0129)	(0.00865)	(0.0314)	(0.0256)	
SQUINSD				–1.33e-05	–0.00252***	
				(0.000537)	(0.000549)	
LVG	0.00135	0.0365	–0.000834	0.0364	–0.000831	0.00103
	(0.0138)	(0.0489)	(0.00673)	(0.0490)	(0.00658)	(0.0121)
EBTD MRGN	0.0108	0.00724	0.00757	0.00719	0.00336	0.00746
	(0.0119)	(0.0213)	(0.0105)	(0.0214)	(0.0105)	(0.0107)
SIZE	–0.0670	–0.0318	–0.0871	–0.0310	–0.0267	0.0794
	(0.0689)	(0.127)	(0.0756)	(0.132)	(0.0772)	(0.0778)
INSTSIZE						–0.00465*
						(0.00245)
INSDSIZE						
Constant	1.657***	1.335	2.112***	1.328	1.485**	0.863*
	(0.493)	(0.877)	(0.559)	(0.932)	(0.580)	(0.464)
R^2	0.311	0.277	0.150	0.451	0.544	0.220
Obs	1718	845	873	845	873	1718
Number of Tickers	940	460	480	460	480	940

Standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1.
Source: Author's own calculations and elaborations.

Hypothesis 1.1 about the inverse U-shaped relationship between institutional ownership and innovation intensity is rejected in the consumer and industrial sectors, which demonstrates conflicting results [16], refuting the fact that preferences for risky R&D investments decrease over time, moving into the phase of a conservative investment program with a high payback guarantee for institutional investors. The alternative hypothesis is not rejected in the IT sector in the total sample where the U-shaped relationship is confirmed, as mentioned by [21]. These results are not consistent with economic theory, which states as long as the share of institutional investors is below a certain threshold, the incentives to invest in R&D become higher as the share increases, and the risks become less diversified among investors. On the other hand, the IT sector is a protected industry with operating results that are less sensitive to economic cycles. Thus, risks of losses from R&D investments may be absorbed partly by a more stable financial position. At the same time, the majority of a company's institutional investors company may even incentivize such investment projects at the maturity life cycle phase if their incentives are associated with maintaining a competitive advantage and developing new digital distribution channels, competing with industry disruptors.

Table 13. Empirical results of regression on the impact of ownership structure on innovative activity for Materials industry

Model	Linear model			Quadratic model		Iterative model
Life Cycle	General	Growth	Mature	Growth	Mature	General
Variables	R&D to NS	R&D to NS	R&D to NS	R&D to NS	R&D to NS	R&D to NS
INST	0.00367	0.0181***	–0.00946***			
	(0.00292)	(0.00403)	(0.00338)			
INSD				8.39e-05	–0.0574***	
				(0.0261)	(0.0175)	
SQUINSD				–0.000241	0.00116***	
				(0.000544)	(0.000299)	
LVG	0.0976***	0.0438*	0.118***	0.209***	0.211***	0.0970***
	(0.0153)	(0.0262)	(0.0128)	(0.0611)	(0.0174)	(0.0153)
EBTD MRGN	0.00110	0.000489	–0.00330	0.00823	–0.00234	0.000996
	(0.00729)	(0.00946)	(0.00840)	(0.0117)	(0.0100)	(0.00728)
SIZE	–0.148***	–0.151**	–0.151*	–0.0313	–0.262***	–0.174***
	(0.0548)	(0.0684)	(0.0780)	(0.0772)	(0.0874)	(0.0596)
INSTSIZE						0.00273*
						(0.00164)
INSDSIZE						
Constant	2.386***	1.896***	3.091***	1.980***	4.067***	2.531***
	(0.348)	(0.422)	(0.534)	(0.538)	(0.639)	(0.366)
R^2	0.491	0.364	0.108	0.114	0.484	0.207
Obs	2978	1706	1272	1706	1272	2978
Number of Tickers	552	316	236	316	236	552

Standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1.

Source: Author's own calculations and elaborations.

Hypothesis 2 about the negative impact of insider ownership on innovation intensity is not rejected in the consumer sector at the maturity stage and IT sector at all stages of the life cycle, while in the industry sector, the hypothesis is rejected at all stages of the life cycle due to lack of significance. In the IT sector, companies invest in R&D throughout the entire life cycle because companies compete for the best technological product. Therefore, the risks of investing in R&D are higher as the future company cash flows depend on the investment outcome. In conditions where board members are also the company's managers (insiders), they assess the risks of losing their current positions or privileges as higher when investing in innovations, and, therefore, the incentive for such investments is reduced. At the same time, for the consumer sector, this effect is significant at the stage of maturity, when insiders' interests do not correlate with the company's interests to maintain competitive advantages and do not move to the stage of decline.

Hypothesis 2.1 regarding the inverse U-shaped relationship between insider ownership and innovation intensity is not rejected at the maturity stage for the consumer sector, while in other sectors, either the alternative hypothesis is accepted (industrial sector), or linear coefficients are not significant for all stages of the life cycle (IT). In contrast, the non-linear relationship type for the consumer sector suggests that the incentives to invest in R&D change as ownership concentration increases, and is linked to the firm's long-term goals when insider ownership concentration is small.

Hypothesis 3, which states that ownership concentration has a stronger effect in large companies, is partly not rejected for the consumer and IT sectors (for institutional owners) in the light and heavy industries, the hypothesis is not confirmed. It is worth noting that in the consumer and IT sectors investors are more frequently faced with the choice of influencing the company through lower monitor-

ing costs. For investors with some business interest in their portfolio companies, monitoring costs are significantly higher than the corresponding costs of independent investment firms. Over time, from the start of the investment, monitoring costs are reduced by accumulated knowledge about the company, as a consequence, large companies can reduce costs on their part for institutional investors by facilitating their access to management and the board of directors. It is confirmed by the empirical analysis by [23] that when a company grows larger, the share of investor ownership increases.

Hypothesis 4, which states that the effect of ownership concentration on the intensity of innovation increases in the transition from growth to maturity life cycle is rejected for the consumer and industry sectors, while for the IT sector, it is true at all life cycle stages. Scientific and technological progress has led to the compression of financial and economic space, given that the most mobile resource for the formation of global financial capital for innovative development is comprised by the funds of institutional investors, which are in free circulation in the economy. Investors favor more stable firms at the maturity stage, as their potential benefits increase with the investment horizon and with the length of shareholding. The regression analysis estimates in Table 10 indicate that the effect of institutional ownership concentration on innovation intensity increases as the firm moves towards maturity as also mentioned in the papers of [24; 29].

Hypothesis 5, which states that ownership concentration has a more pronounced impact in industries with high innovation intensity, is not rejected. It is difficult to compare the impact estimates between sectors with different direct innovation intensities because of the difference in directional effects and lack of significance for similar indicators. First, we test the hypothesis that innovation intensity is statistically higher in IT. The results of regression analysis in Table 11 show that when moving from the consumer to the IT industry, the intensity of innovation increases by 5.4%, and in other cases, results are not significant. Then, it is possible to compare the results of the coefficients in the IT industry with the results for the total sample (Table 10). Indeed, the effect of institutional ownership is amplified in the IT industry in a positive direction and for insider ownership – in a negative direction. This pattern is consistent with the theory that a higher risk of R&D investment in the IT industry increases the agency conflict between owners and managers, and different forms of ownership have a more pronounced effect on the resulting outcome.

Conclusion

In South Asia, investors are more frequently faced with the need to decide how to influence a company by reducing monitoring costs. Expenditure management is significantly higher for investors with a business interest in their portfolio companies than in independent investment firms. Expenditure management is lowered by the accumulated knowledge about the company from the moment the investment is initiated, and as a consequence, large companies can reduce costs for institutional investors by facilitating their access to management and the board of directors. As the company grows, the ownership share of investors increases, which is confirmed by empirical analysis. It is also worth noting the impact of scientific and technological progress, which has led to the compression of the financial and economic space, given that the most mobile resource for the formation of global financial capital for innovative development is comprised by the funds of institutional investors, which are in free circulation in the economy. Investors favor more stable firms at the maturity stage, as their potential benefits increase with the investment horizon and the duration of stock ownership. Estimates from regression analysis demonstrate that the effect of institutional ownership concentration on innovation intensity increases as the firm moves toward the maturity stage.

Companies from different industries attach essential strategic importance to R&D investments to maintain leadership and competitive advantage in creating new technologies of various types – product, process, and marketing or adapting existing technological practices. However, it is worth noting that many research gaps in the study of the impact of different forms of ownership on innovation intensity remain. These research studies are limited to resource theory and agency conflict theory without considering the stages of the life cycle and industry specifics. The results of this paper provide a better understanding of the relationship between the concentration of different forms of ownership and innovation intensity (R&D to Net Sales) with these aspects and thus complement the underlying theories. First of all, a high concentration of institutional ownership has a stimulating effect on innovation intensity in the high-tech IT industry and enhances it in the transition to the maturity stage, moreover, in low-tech sectors it can have a multidirectional effect depending on the stage of the life cycle in the industrial sector and a negative impact in the consumer sector. Secondly, the closer to maturity, the greater the U-shaped dependence relationship in the consumer sector, which is due to the specifics of this industry. Thirdly, the high concentration of insider ownership has a restraining effect on the intensity of innovation for IT throughout the entire life cycle, and at the maturity stage for the consumer sector. At the same time, there is no significant effect on ownership concentration on industry. Fourth, this effect has an inverse U-shaped dependence at the maturity stage in the consumer industry, which is not typical for other sectors. Fifth, for large firms, the high concentration of institutional ownership encourages firms in the consumer and IT industries to maintain a high level of innovation intensity. The hypothesis that high innovation intensity is significantly progressing in the IT industry and that the incentive effect of institutional ownership and the disincentive effect of insider ownership are progressing in these industries is also confirmed. The regularities confirm the actuality of analyzing the industry specifics and drawing conclusions about specific dependences, dividing com-

panies by industry. It is worth noting that the localization of the world leaders' production facilities in R&D investments in different regions is still uneven, which requires consideration of cultural and institutional peculiarities in future studies. Moreover, based on the results, we can see that the impact of various forms of ownership on R&D investment intensity in many ways is determined by the technological complexity of the industry and the life cycle, which is to be considered in future research.

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Multifactor Trend Model of Sustainable Company Growth in the Context of Competition and Inflation

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Abstract

The present research analyzes corporate growth against the background of competition and inflation, with a focus on the sustainable growth concept. The existing sustainable growth models are more suitable for solving the inverse problem when funding sources are defined at a predetermined growth rate, and less effective for solving the direct problem of sales volume planning when initial data is known. This is due to the fact that traditional models leave out external growth factors. Although inflation models of sustainable growth have remedied the situation, they are still dismissive of competition. The offered multifactor trend model of sustainable growth bridges this gap by taking into consideration the key growth drivers: investment ratio, asset turnover, return on sales, financial leverage and dynamics of product and resource prices. Differential and integral calculus methods were applied to develop the model, and financial ratios are considered as dynamic values described by the trends that are indicative of the external environment impact. The model potential is exemplified in various industries. It provides an opportunity to model the company's entire life cycle, including a period of decline, and may be used as a strategic planning tool. The model describes natural, typical and logistics growth and may be used at the early stages of the life cycle when data is limited.

Keywords: inflation, financial ratio, trend, competition, sustainable growth, logistics growth, industry growth, life cycle, current and strategic planning

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To my granddaughter Valentina!

Introduction

A multivarious mathematical apparatus, in particular differential calculus and regression analysis [1], is used to study companies' performance. The importance of regression models [2–10] resides in the opportunity to take into consideration non-financial growth factors, while differential models are constructed exclusively on the basis of accounting data. An example of the latter are sustainable growth models [11–16], which are differential equations with the coefficients that show the relationship between the balance sheet and revenue. While econometric studies confirm statistical hypotheses laid down descriptively on the basis of general theoretical premises, the models that evaluate growth in reliance on a cause-and-effect relationship pertain to fundamental analysis. Initially, such models took into consideration only the factors that are indicative of internal capabilities of the company, and subsequently – external ones related to inflation [17]. The inflation-related components of the product and manufacturing resource prices may be taken into account separately [18]. The full potential of sustainable growth models is not brought out, especially taking into account the fact that they take inflation into account.

Integration of differential models allows us to analyze the long-range trends of revenue time series. When integrating the sustainable growth equations, exponential trends with a constant increment rate are obtained. To depart from a simple exponent, it is incumbent to take into consideration the temporal dynamics of the financial ratios involved in the integration. The paper dedicated to the forecasting of financial ratios used to define the company value provides the necessary information [19]. This research covers the ratios that constitute a decomposition of return on equity according to the DuPont chart. It was established that as time goes by, they approximate the typical levels which, according to the industry-adjusted DuPont model [20], may be represented by industry-specific medians. These dynamics may be caused by competition, which eliminates the deviation of the ratios from typical levels. There is a belief that this is the way to ensure the optimal operational structure of a company. Since profitability directly influences the sustainable growth rate. the increase in complexity of the models usually consists in adding of new indicators from the DuPont chart. As a result, information on long-term trends in the majority of financial ratios significant for company growth has been accumulated by now.

It follows from the industry-adjusted DuPont model that over time the increment rate approximates the industry level. This assumption is in line with the two-stage business value estimation model which divides the time horizon into the forecast and post-forecast periods. The initial stage may be characterized by an increased increment rate because the company has a "window of opportunity" due to competitive advantages [21]. As and when they are lost, the stable growth stage starts. During this stage, the window of opportunity grows simultaneously with the industry. This stage may be described by an exponent with a constant increment rate. The transition from one stage to another is accompanied by changes in the value of financial ratios that influence the rate of revenue increment: return on sales, financial leverage, undistributed profit, asset turnover. Empirical data [19; 20; 22] shows that there may be different directions of financial ratios' deviation from typical values. Therefore, at the initial stage, apart from the "window of opportunity", a reverse situation may occur when over time the company improves its performance achieving the industry average values.

If we come to the macroeconomic level, according to the Harrod-Domar model [23, p. 64], the exponential growth with a constant increment rate called the guaranteed [24] or equilibrium [25] one is possible in the circumstances of sustainable development when the rates of increment in investment and production output are identical and equal to the product of the savings rate and the marginal productivity of capital. Premised on the fact that with time business growth approximates the industry growth, which, in turn, depends on the macroeconomic environment, it is fair to assume that there is a relationship between the company's ratios and macroeconomic indicators that determine the equilibrium growth. The sustainable growth and Harrod-Domar economic growth models have something in common. In both cases a fixed share of income goes back to the production process, thus, increasing the used funds and providing the basis for exponential growth. This is indicative of the prospect of applying sustainable growth models at higher levels of economic indicators' aggregation.

The purpose of this research is to develop a sustainable growth model that takes into consideration the impact of inflation and competition. For this purpose, trends of financial ratios are added to the inflation model with a transfer from the differential to the integrated form. The trends of inflation of manufacturing resource price and the spread of inflation of company's product and manufacturing resource price take price environment changes into consideration. Trends of the ratios of undistributed profit, asset turnover, return on sales and financial leverage manifest changes in the operating structure of the company under the pressure of competition.

Model

Two similar indicators are used to analyze the economic value dynamics: growth rate and increment rate. They describe the dynamics using the relationship between the values that pertain to different time points. For revenue that takes on the value of S_t at time t, the periodic growth and increment rates are described by the expressions $\frac{S_{t+T}}{S_t}$ and $\frac{\Delta S_{t+T}}{S_t}$, where T is duration of the analyzed period; $\Delta S_{t+T} = S_{t+T} - S_t$ is the absolute increment.

The actual values of periodic indicators may be calculated on the basis of accounting data. With $T \to 0$ we get the revenue increment rate of $\frac{dS_t}{dt}\frac{1}{S_t}$ where $\frac{dS_t}{dt}$ is the rate of revenue receipt. The relationship between the increment rate and the periodic growth rate is as follows:

$$\int_t^{t+T}\left(\frac{dS_{t'}}{S_{t'}}\frac{1}{dt'}\right)dt' = \int_t^{t+T}\frac{dS_{t'}}{S_{t'}} = \ln\left(\frac{S_{t+T}}{S_t}\right).$$

Some sustainable growth models (for example, [13]) describe the periodic increment rate, while others (for example, [18]) describe the increment rate. The present paper analyzes the revenue increment rate.

Fundamental Equation

The revenue increment rate $g_t = \frac{dS_t}{dt}\frac{1}{S_t}$ of a steadily growing business is proportional to the equity increment rate $\frac{dE_t}{dt}\frac{1}{E_t}$:

$$g_t = \left(\frac{dE_t}{dt} - \frac{dP_t}{dt} + \frac{dB_t}{dt}\right)\frac{1}{E_t} = b_t\frac{dE_t}{dt}\frac{1}{E_t}, \qquad (1)$$

where $\frac{dE_t}{dt}$ is the rate of change in equity E_t before making payments to shareholders; $\frac{dP_t}{dt}$ and $\frac{dB_t}{dt}$ are the rates of dividend payment and stock issue;

$$b_t = \frac{\left(\frac{dE_t}{dt} - \frac{dP_t}{dt} + \frac{dB_t}{dt}\right)}{\left(\frac{dE_t}{dt}\right)}$$

is the investment ratio responsible for payments to shareholders. If only net income was the source of corporate equity growth, equity equals the undistributed net profit ratio.

According to the inflation model [18] the rate of equity change equals:

$$\begin{aligned}\frac{dE_t}{dt} &= m_tS_t + (i_t - j_t)(1-\phi_t)S_t - \\ &-\varepsilon_t\alpha_t(1-\phi_t)\left[\beta_{1,t}(C_t + I_t - L_t) + \beta_{2,t}F_t\right]S_t + \\ &+ j_tF_t(\kappa_t + o_t)(1-\phi_t)S_t + \\ &+ j_t\left[I_t + F_t - F_t(\kappa_t + o_t)\right]S_t,\end{aligned} \qquad (2)$$

where m_t is the actual return on sales, which equals the ratio of net profit exclusive of inflation to annual revenue S_t; C_t is the ratio of cash and net receivables to annual revenue; L_t is the ratio of accounts payable and other spontaneous liabilities to annual revenue; I_t is the ratio of inventories to annual revenue; F_t is the ratio of net fixed assets to annual revenue; κ_t is the depreciation rate; o_t is the rate of unforeseen depreciation, $\beta_{1,t} = \frac{D_{1,t}}{(C_t + I_t - L_t)S_t}$ is the share of working capital financed from debt $D_{1,t}$; ϕ_t is the profit tax rate; $\beta_{2,t} = \frac{D_{2,t}}{F_tS_t}$ is the share of fixed assets financed from debt $D_{2,t}$; α_t is the share of debt with a free-floating interest rate; i_t is inflation of the corporate product prices; j_t is inflation of manufacturing resource prices; e_t is the adjustment of the loaned funds' interest rate due to inflation. When the price dynamics are described, inflation serves as an analogue of the increment rate.

It follows from the definitions of $\beta_{1,t}$ and $\beta_{2,t}$ that financial leverage $(D/E)_t$ equals

$$\left(\frac{D}{E}\right)_t = \frac{\beta_{1,t}(C_t + I_t - L_t)S_t + \beta_{2,t}F_tS_t}{(1-\beta_{1,t})(C_t + I_t - L_t)S_t + (1-\beta_{2,t})F_tS_t}, \qquad (3)$$

where debt D_t and equity E_t are described by the following expressions: $D_t = D_{1,t} + D_{2,t} = \beta_{1,t}(C_t + I_t - L_t)S_t + \beta_{2,t}F_tS_t$ and $E_t = (1-\beta_{1,t})(C_t + I_t - L_t)S_t + (1-\beta_{2,t})F_tS_t$. Henceforward, fractions in parentheses are considered as financial ratios.

Model (1) takes into consideration the possibility of raising equity by means of stock issue ($b_t > 1$). Apart from that, undistributed net profit and asset revaluation contribute to equity growth. According to (2):

a) Net income exclusive of inflation m_tS_t:

grows by $(i_t - j_t)(1-\phi_t)S_t$ due to the difference in inflation of product and manufacturing resource inflation;

decreases by $e_t\alpha_t(1-\phi_t)\left[\beta_{1,t}(C_t + I_t - L_t) + \beta_{2,t}F_t\right]S_t$ because the interest on borrowed funds is paid;

rises by $j_tF_t(\kappa_t + o_t)(1-\phi_t)S_t$ because depreciation does not take into consideration the increase in the cost of fixed assets caused by inflation;

b) the final growth factor is related to an increase in the cost of previously purchased inventories and fixed assets by $j_t\left[I_t + F_t - F_t(\kappa_t + o_t)\right]S_t$, and it is shown in (2) as an increment in add-on capital due to increases in asset value.

Asset turnover financed without accounts payable and other spontaneous liabilities $\left(\frac{S}{A}\right)_t$ equals

$$\left(\frac{S}{A}\right)_t = (C_t + I_t - L_t + F_t)^{-1}, \qquad (4)$$

and on this basis, we obtain the fundamental equation of the trend model of sustainable growth taking into consideration (1)–(3):

$$g_t = b_t\left\{\left[\left(\frac{S}{A}\right)_t\left(m_t + z_t(1-\phi)\right) + j_t\varepsilon\right]\left[1+\left(\frac{D}{E}\right)_t\right] - e_t\alpha(1-\phi)\left(\frac{D}{E}\right)_t\right\}, \quad (5)$$

where $z_t = i_t - j_t$ is the spread between inflation of product and manufacturing resource prices;

$\varepsilon = \dfrac{I_t + F_t\left[1-\phi(\kappa_t + o_t)\right]}{C_t + I_t - L_t + F_t}$ is the ratio of revaluated assets to the assets financed exclusive of spontaneous liabilities. When integrating this indicator, the share of debt with the free-floating interest rate and income tax are considered to be constant, therefore in (5) they are presented without the time index. The rest of the ratios are considered as dynamic quantities.

Trend Model

To take into account a change in financial ratios over time, we introduce their long-term trends into equation (5). According to empirical data, they comply with the pattern represented by a modified exponent (see Appendix 1):

$$b_t = h_0 + h_1 e^{\delta t}, \quad \left(\frac{S}{A}\right)_t = f_0 + f_1 e^{\xi t},$$
$$m_t = c_0 + c_1 e^{\gamma t}, \quad \left(\frac{D}{E}\right)_t = l_0 + l_1 e^{\lambda t}, \quad (6)$$
$$z_t = y_0 + y_1 e^{\eta t}, \quad j_t = n_0 + n_1 e^{\pi t},$$

where $h_0, f_0, c_0, l_0, y_0, n_0$ are the final values of trends, which show their limit at $t\to\infty$ with deviations at the initial time point, which equal $h_1, f_1, c_1, l_1, y_1, n_1$ and the deviations' increment rates of δ, ξ, γ, λ, η, π. To avoid trends' (6) tending to infinity, the deviations' increment rates should be less than zero.

The final values of trends may equal the typical values which, according to the DuPont industry-adjusted model, are equivalent to industry-specific medians. We are going to call a company with such final values typical. It is presumed that far from all companies are considered typical.

Corporate expenses are formed by expenses that are heterogeneous in terms of economic content and purpose, therefore, inflation of manufacturing resource prices is roughly equivalent to general economic inflation. According to Fisher's effect, it also determines the adjustment of the loaned funds' interest rate. Thus, these growth factors match in terms of value: j = e.

We subsequently obtain the differential multifactor trend model, which describes the revenue increment rate from equation (5), taking into consideration (6) and the equality $j = e$ (see Appendix 2):

$$g_t = p_0 + \sum_{k=1}^{27} p_k e^{q_k t}, \quad (7)$$

with the following constant ratios:

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

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

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

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

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

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

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

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

$$p_{12} = h_0 f_1 c_1(1+l_0), \quad q_{12}=\gamma+\xi, \quad p_{13} = h_1 f_1(1+l_0)\left[c_0 + y_0(1-\phi)\right], \quad q_{13}=\xi+\delta, \quad (8)$$

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

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

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

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

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

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

$$p_{26} = h_1 f_1 c_1 l_1, \quad q_{26}=\gamma+\xi+\lambda+\delta, \quad p_{27} = h_1 f_1 y_1 (1-\phi) l_1, \quad q_{27}=\eta+\xi+\lambda+\delta. \quad (6)$$

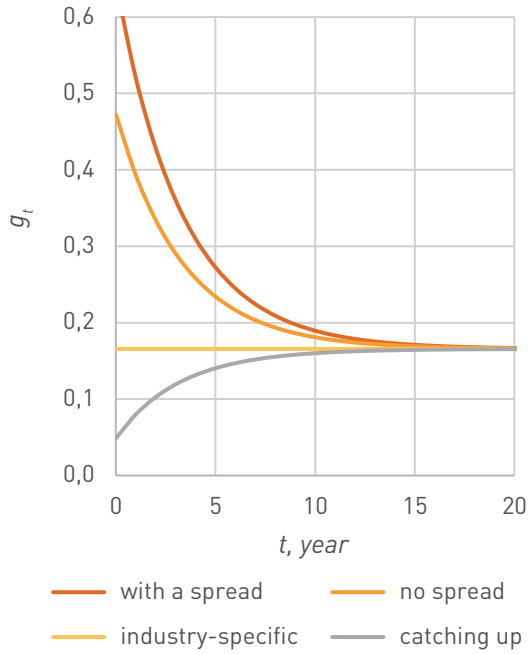
Having integrated (7), we obtain a multifactor trend model that describes the trajectory of the sustainable growth of company revenue:

$$S_t = S_0 \exp\left[p_0 t - \sum_{k=1}^{27} \frac{p_k}{q_k}\left(1-e^{q_k t}\right)\right] \quad (9)$$

where S_0 is revenue at the initial time point.

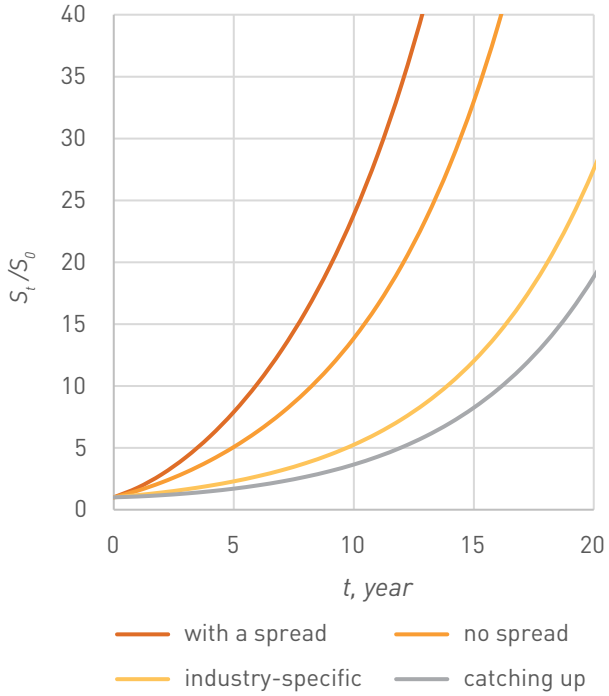
Graphic Analysis

Figure 1. Increment rates



We are going to graphically analyze the differential (7) and integrated (9) models (Figures 1 and 2). The financial ratios applied to construct the graphs are presented in Appendix 3 (with the information used to build the graphs presented in Figures 7 and 8). The final values of the financial ratios' trends in all examples equal the industry values, therefore, as time passes, revenue increment rates become identical, approximating the industry level. The speed of achieving this state is defined by the deviation increment rates. They are the same for all financial ratios. The revenue increment rate depends on the spread of product and manufacturing resource prices. A positive spread accelerates sustainable growth significantly. A company that is catching-up is distinct from others by the negative price spread and decreased initial values of return on sales and investment ratio. When the industry growth stage is reached, the increment rate graph becomes straight. At this stage, the growth trajectory is described with a simple exponent. In all other cases, despite the exponential form, the revenue growth is not simple because the increment rates are not constant. The presented dependencies plotted using the trends whose final values are equal to the typical ones, may be called typical. Atypical sustainable growth trajectories are considered below.

Figure 2. Sustainable growth trajectories



Data

The trend model takes into consideration the dynamics of financial ratios, providing an opportunity for us to study growth at a long-term time horizon. We apply it to calculate the growth trajectories (Figures 3a–6a) and revenue increment rates (Figures 3b–6b) of the companies operating in various fields. Theoretical graphs are indicated as solid lines while empirical graphs – as dash-dot lines. The accounting information is obtained in the SCRIN database. Inflation of product and manufacturing resource prices of companies was taken to be equal to general economic inflation, except for PJSC VimpelCom. For this company, product price dynamics was estimated by the average price per minute (APPM)[1]. Based on the bank's right to determine the cost of lending unilaterally, the interest rate of all loans was considered to be free floating. Financial ratios' trends, except for the investment ratio, are constructed by approximating empirical data with equations (6). As at the

[1] The data from [26] was used.

end of the 1990s, accounting information was sometimes incomplete, therefore, the approximation procedure covered the period which started in the 2000s. The investment ratio depends not just on payments to shareholders, but also on changes in the asset value caused by inflation. It was calculated on the basis of the accounting data and turned out to be inaccurate because the analyzed companies extremely rarely revalued non-current assets. In order to bypass this obstacle, the model was calibrated using this ratio, while its trends remained within the statistical scatter of the empirical data. Comparison of the graphs shows that the modeling results are in line with the practice, except for the economic shock periods which disrupt the existing trends for a short time. This may be exemplified by performance degradation of PJSC Aeroflot in 2020 as a result of a decline in air transportation caused by the COVID-19 pandemic (Figure 5).

Discussion

Up to the present time, theoretical analysis revolved around typical scenarios of company operations, which imply that over time financial ratios gravitate towards the levels preset by industry-specific medians. Empirical data analysis shows that the typical scenario is not always implemented. We are going to consider special cases of the trend model that demonstrate sustainable growth in other economic environments, which are described by theories and occur in practice.

Figure 3. JSC Wimm Bill Dann

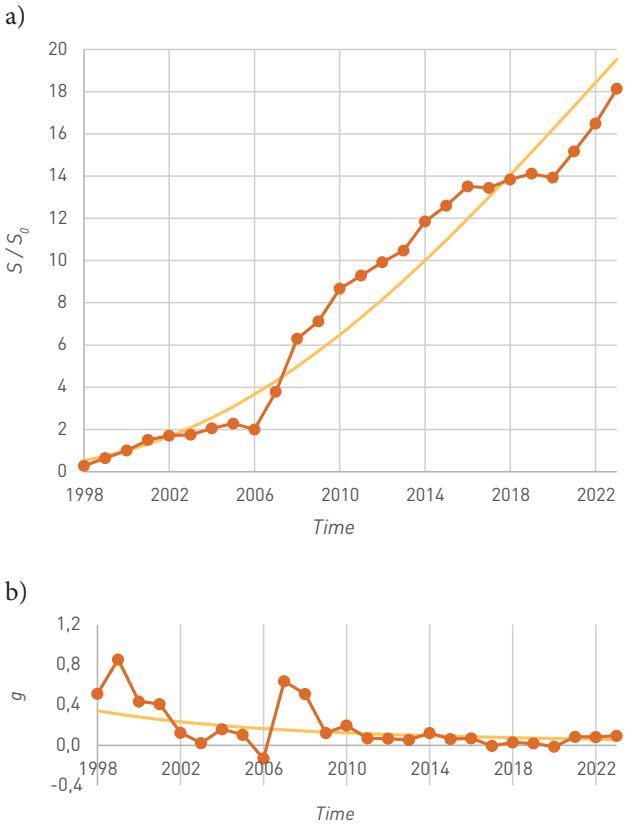


Figure 4. PJSC VimpelCom

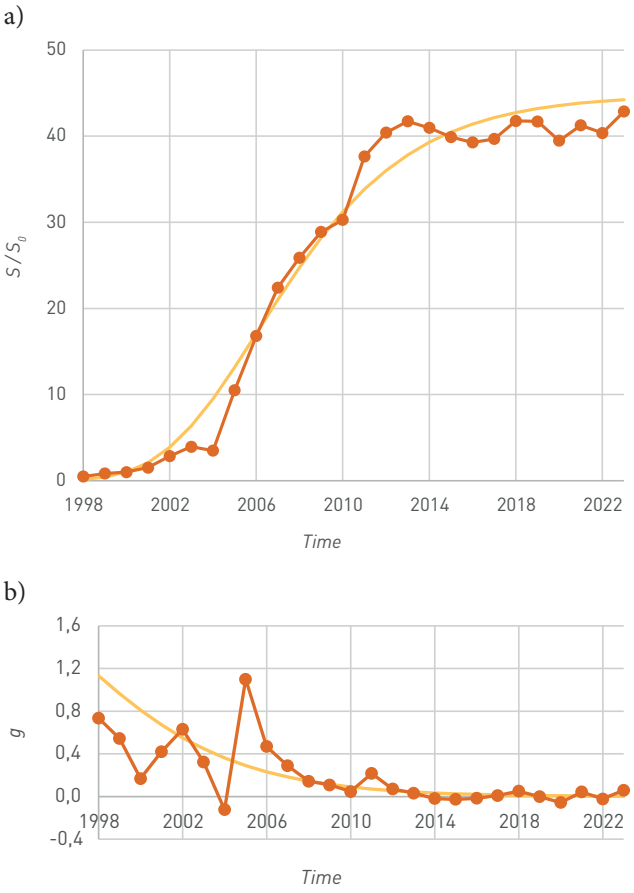


Figure 5. PJSC Aeroflot

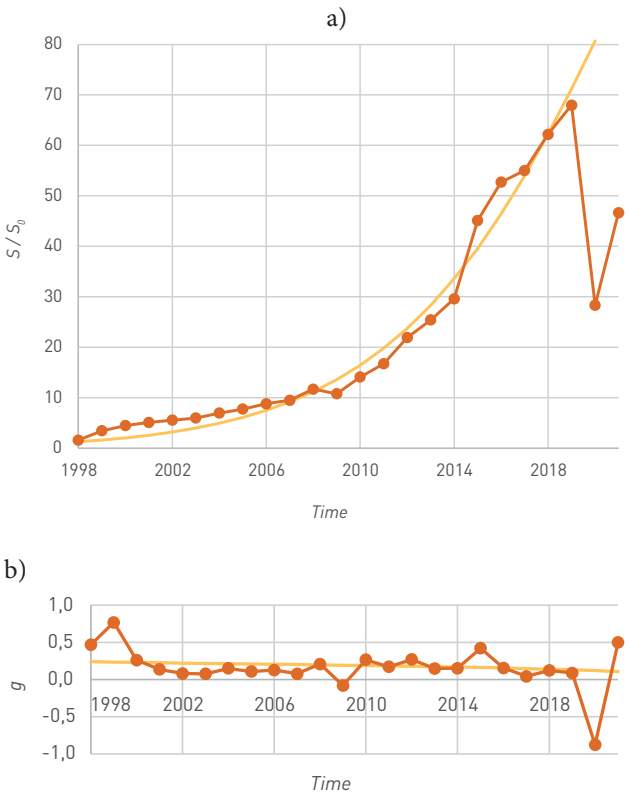
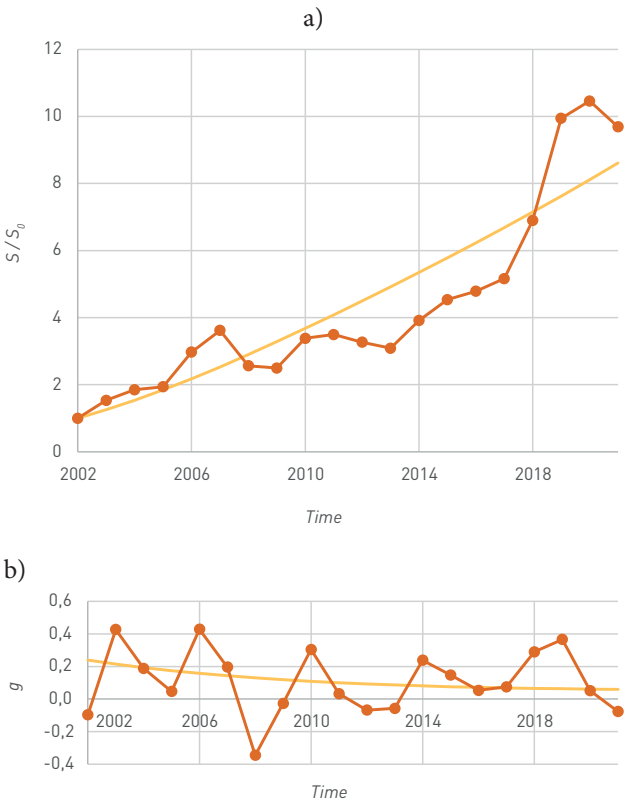


Figure 6. PJSC Mining and Metallurgical Company Norilsk Nickel



Natural Growth

Suppose that financial ratios remain unchanged over time. In order to model this situation, we zero out the increment rates of trend deviations (6) in the differential equation (7). After the integration of the obtained equation, we obtain the following model:

$$S_t = S_0 e^{\sum_{k=0}^{27} p_k t}, \quad (10)$$

that describes exponential growth with a constant increment rate. It may be observed in a competition-free environment when a company sells the manufactured products unhindered and allocates a part of income to production expansion. The typical levels are concealed here. If we consider the absence of competition to be the main feature of natural growth, equation (10) is its model. In practice the conditions required for natural growth emerge when a company stands at the origins of a new industry, defining its standards. Innovator enterprises called "gazelle companies" show aggressive growth well-described by a simple exponent [27]. Note that the time horizon covered by the model (10) is not limited to the initial time interval. The passage to the limit $t \to 0$ also provides an exponential dependence with a constant increment rate; however, this solution does not implicate an absence of competition.

Industry Growth

The industry-adjusted DuPont model shows that the typical levels of financial ratios are presented by industry-specific medians. So, having zeroed out the trend deviations (6) from typical levels ($l_1 = h_1 = c_1 = f_1 = y_1 = n_1 = 0$) we obtain the following model instead of (9):

$$S_t = S_0 e^{p_0 t}, \quad (11)$$

where p_0 is the industry increment rate (annual). It is a time-constant value. At the macroeconomic level, equilibrium (guaranteed) Harrod-Domar growth is characterized by a constant increment rate. Hence, we get a "macroeconomic" method of p_0 calculation by means of the product of the industry-specific savings rate and the marginal productivity of capital. If we apply this method to calculate p_0, then, based on the obtained value as a selection criterion we may find the companies close to the stage of industry growth and use them to determine the typical values of financial ratios without analyzing their time series. It should be noted that in practice it is impossible to achieve the stage of industry growth. This virtual state exists only on paper because the typical levels are attained by financial ratios only with $t \to \infty$.

Logistics Growth

The distinctive feature of exponential models is the fact that they cause unrestricted growth. It is absent in the models based on the diffusion equation where a logistic curve replaces the exponent [28; 29]. Some diffusion models were used successfully to describe the economic processes related to the diffusion of innovation and sale of high-tech products [30–33]. At the initial stage, the logistic dynamics are close to exponential dynamics and describe growth that is similar to natural one. The competitive pressure related

to innovators and imitators is still not strong at this stage. The curve smooths out gradually and reaches a plateau. Using the trend model (9), one may model sustainable growth similar to logistics growth - initially exponential, subsequently halting growth (Figure 7). It is obtained when the final trend values of certain financial ratios are set to zero. One may see the combinations necessary for this purpose in equation (5). The figure shows the version with the zero final values of return on sales, interest rate spread, manufacturing resource price inflation and financial leverage. A similar result is obtained when only the final value of the investment ratio is set to zero.

Figure 5. Logistic trajectory of sustainable development

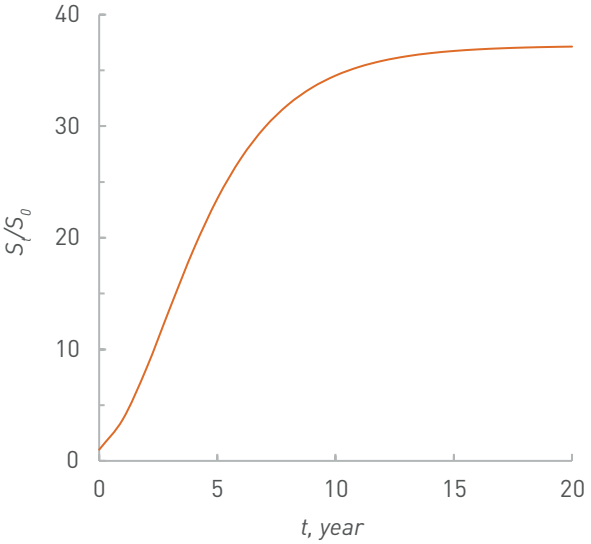
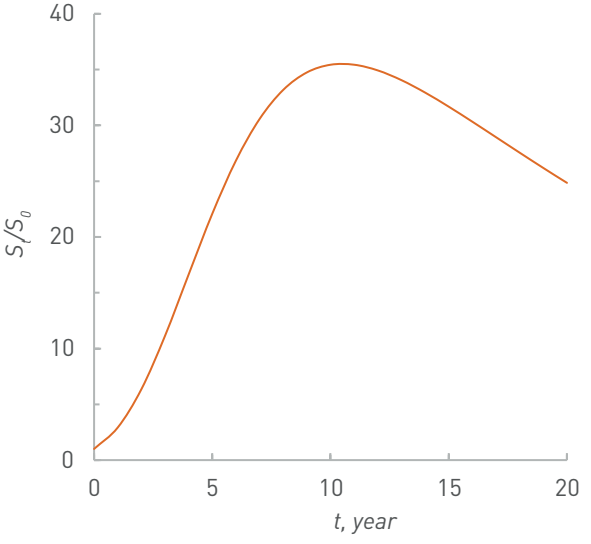


Figure 6. Sustainable growth trajectory with a decline period



Life Cycle

According to the life cycle concept, the growth period within which financial ratios approach the typical levels is not necessarily the last one [34–37]. At any stage, a failed company may go bankrupt having passed the zero growth and decline periods. The typical financial ratio trends neutralize such cases because they are built on the basis of the industry-specific medians. In order to model the history of a failed company by applying (7) and (9), it is necessary to use the individual final trend values, which lead to a negative revenue growth rate, instead of typical ones (Figure 8). Different combinations are possible. All prosperous companies are alike, while each failed company goes bankrupt in its own way[2]. The abovementioned curve is obtained at the negative final return on sales. It covers the zero growth and decline stages.

Conclusion

While previous sustainable growth models were effective in solving the inverse problem when funding sources were defined at a predetermined increment rate, inflation-related modifications may be applied to solve the direct problem, namely, planning revenue at predetermined values of financial ratios. The trend model presented in this paper is best suited for this purpose because it eliminates the most significant drawback of sustainable growth models, i.e., overlooking of external environment conditions. The typical trends of financial ratios allow to apply the model at early stages of the company life cycle when there is a lack of historical data. It covers various scenarios and may be used as a strategic planning tool. To operate for a long time and generate profit, a company has to focus on the typical growth strategy. The natural growth strategy suits an innovator company. The logistics growth strategy is useful in a limited market.

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[2] By analogy with the epigraph to the novel by L.N. Tolstoy Anna Karenina "All happy families are alike; each unhappy family is unhappy in its own way"

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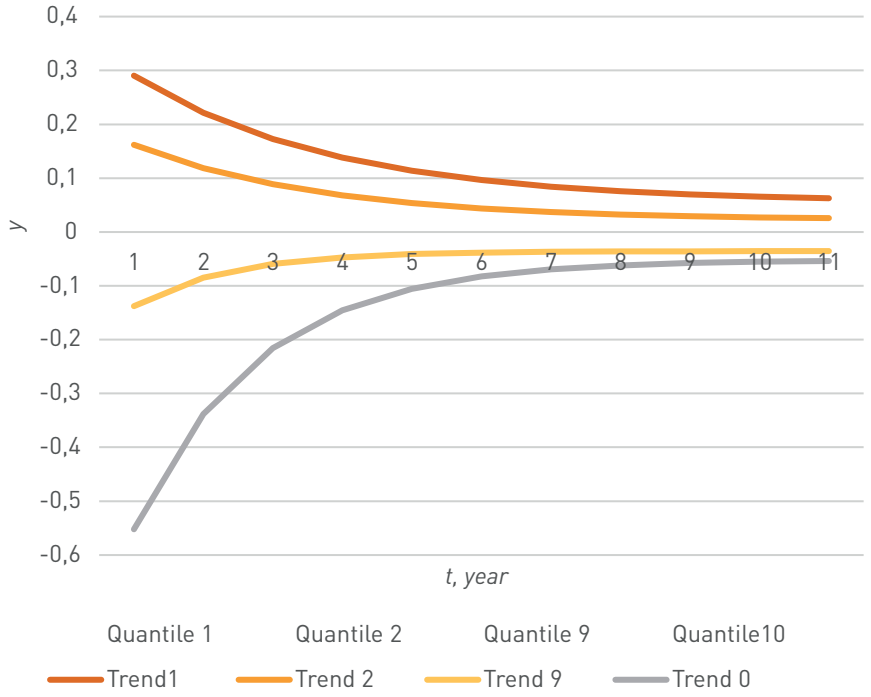
Appendix 1

Pattern Trends

Trends of financial ratios have been studied in detail [19; 20; 22]. In the course of these studies, we compiled a sample of companies and constructed five-year or ten-year time series of financial ratios for them. Based on the zero period values, they were grouped by deciles, and group medians were subsequently analyzed. It was established that the time dynamics of the ratios' medians follow a certain pattern. One may get an idea of it by return on sales (Figure 9). Empirical data from [20] was used to construct the presented graphs, they are denoted by markers. As time passes, the medians tend to achieve the level referred to as typical [19]. According to the DuPont industry-adjusted model [20] it is representative of the industry. The greater the current deviation, the more pronounced the movement of the indicator towards the typical level. Such dynamics are indicative of the exponentiality of pattern trends, which is confirmed by the results of approximation of empirical data by functions $y = a + be^{ct}$, where y is the deviation of the median of the corresponding decile from the typical level; a, b, c – constants; t – time. In Figure 9, the results of approximation are shown as lines.

Figure 7. Dynamics of return on sales deviations



Appendix 2

Differential Trend Model

Equation (5) taking into consideration (6) is as follows:

$$g_t = b_t\left(\left\{\left(\frac{S}{A}\right)_t\left[m_t + z_t(\alpha - \phi)\right] + j_t\right\}\left[1 + \alpha\left(\frac{D}{E}\right)_t\right] - e_t(1-\phi)\left(\frac{D}{E}\right)_t\right) =$$

$$= (h_0 + h_1 e^{\alpha t})\left(\left\{\left(f_0 + f_1 e^{\beta t}\right)\left[\left(c_0 + c_1 e^{\alpha t}\right) + \left(y_0 + y_1 e^{\gamma t}\right)(1-\phi)\right] + \left(n_0 + n_1 e^{\delta t}\right)\right\} \times\right.$$

$$\left.\times\left(1 + l_0 + l_1 e^{\varepsilon t}\right) - e_t(1-\phi)\left(l_0 + l_1 e^{\varepsilon t}\right)\right) = (h_0 + h_1 e^{\alpha t}) \times$$

$$\times\left(\left\{f_0\left[\left(c_0 + c_1 e^{\alpha t}\right) + \left(y_0 + y_1 e^{\gamma t}\right)(1-\phi)\right] + f_1 e^{\beta t}\left[\left(c_0 + c_1 e^{\alpha t}\right) + \left(y_0 + y_1 e^{\gamma t}\right)(1-\phi)\right] + \right.\right.$$

$$\left.\left. + n_0 + n_1 e^{\delta t}\right\}\left(1 + l_0 + l_1 e^{\varepsilon t}\right) - e_t(1-\phi)\left(l_0 + l_1 e^{\varepsilon t}\right)\right) = (h_0 + h_1 e^{\alpha t}) \times$$

$$\times\left(f_0 c_0 + f_0 c_1 e^{\alpha t} + f_0 y_0(1-\phi) + f_0 y_1 e^{\gamma t}(1-\phi) + f_1 c_0 e^{\beta t} + f_1 c_1 e^{(\alpha+\beta)t} + f_1 y_0(1-\phi) e^{\beta t} + \right.$$

$$+f_1 y_1 (1-\phi)\alpha e^{(\gamma+\iota)t}(1+n_0+n_1 e^{\delta t})\left(\alpha+\beta(l_0+l_1 e^{\varepsilon t})-e_t(-\phi)(l_0+l_1 e^{\varepsilon t})\right).$$

Given that $e_t = j_t = n_0 + n_1 e^{\delta t}$, we remove parentheses as follows:

$$=(h_0+h_1 e^{\alpha t})\left(f_0 c_0(1+l_0)+f_0 c_1(1+l_0)e^{\beta t}+f_0 y_0(1-\phi)(1+l_0)+f_0 y_1(1-\phi)(1+l_0)e^{\gamma t}+\right.$$

$$+f_1 c_0(1+l_0)e^{\iota t}+f_1 c_1(1+l_0)e^{(\beta+\iota)t}+f_1 y_0(1-\phi)(1+l_0)e^{\iota t}+f_1 y_1(1-\phi)(1+l_0)e^{(\gamma+\iota)t}+$$

$$+n_0\alpha(1+l_0)+n_1\alpha(1+l_0)e^{\delta t}+f_0 c_0 l_1 e^{\varepsilon t}+f_0 c_1 l_1 e^{(\beta+\varepsilon)t}+f_0 y_0(1-\phi)l_1 e^{\varepsilon t}+$$

$$+f_0 y_1(1-\phi)l_1 e^{(\gamma+\varepsilon)t}+f_1 c_0 l_1 e^{(\iota+\varepsilon)t}+f_1 c_1 l_1 e^{(\beta+\iota+\varepsilon)t}+f_1 y_0(1-\phi)l_1 e^{(\iota+\varepsilon)t}+f_1 y_1(1-\phi)l_1 e^{(\gamma+\iota+\varepsilon)t}+$$

$$\left.+n_0\varepsilon l_1\alpha e^{\varepsilon t}+n_1 l_1(\delta+\varepsilon)t-(\alpha n_0+\alpha n_1)e^{\delta t}(-\phi)l_0-(\alpha n_0+\alpha n_1)e^{\delta t}(e-\phi)l_1 e^{\varepsilon t}\right)=$$

$$=h_0 f_0 c_0(1+l_0)+h_0 f_0 c_1(1+l_0)e^{\beta t}+h_0 f_0 y_0(1-\phi)(1+l_0)+h_0 f_0 y_1(1-\phi)(1+l_0)e^{\gamma t}+$$

$$+h_0 f_1 c_0(1+l_0)e^{\iota t}+h_0 f_1 c_1(1+l_0)e^{(\beta+\iota)t}+h_0 f_1 y_0(1-\phi)(1+l_0)e^{\iota t}+h_0 f_1 y_1(1-\phi)(1+l_0)e^{(\gamma+\iota)t}+$$

$$+h_0 n_0\alpha(1+l_0)+h_0 n_1\alpha(1+l_0)e^{\delta t}+h_0 f_0 c_0 l_1 e^{\varepsilon t}+h_0 f_0 c_1 l_1 e^{(\beta+\varepsilon)t}+h_0 f_0 y_0(1-\phi)l_1 e^{\varepsilon t}+.$$

$$+h_0 f_0 y_1(1-\phi)l_1 e^{(\gamma+\varepsilon)t}+h_0 f_1 c_0 l_1 e^{(\iota+\varepsilon)t}+h_0 f_1 c_1 l_1 e^{(\beta+\iota+\varepsilon)t}+h_0 f_1 y_0(1-\phi)l_1 e^{(\iota+\varepsilon)t}+$$

$$+h_0 f_1 y_1(1-\phi)l_1 e^{(\gamma+\iota+\varepsilon)t}+h_0 n_0 l_1(\varepsilon)t+h_0 n_1 l_1(\delta+\varepsilon)t-$$

$$-n_0\alpha(1-\phi)h_0 l_0-n_0\alpha(1-\phi)h_0 l_1 e^{\varepsilon t}-n_1\alpha(1-\phi)h_0 l_0 e^{\delta t}-n_1\alpha(1-\phi)h_0 l_1 e^{(\delta+\varepsilon)t}+$$

$$+h_1 f_0 c_0(1+l_0)e^{\alpha t}+h_1 f_0 c_1(1+l_0)e^{(\beta+\alpha)t}+h_1 f_0 y_0(1-\phi)(1+l_0)e^{\alpha t}+h_1 f_0 y_1(1-\phi)(1+l_0)e^{(\gamma+\alpha)t}+$$

$$+h_1 f_1 y_1(1-\phi)(1+l_0)e^{(\gamma+\iota+\alpha)t}+h_1 n_0(+l_0)\alpha t+h_1 n_1(+l_0)(\delta+\alpha)t+h_1 f_0 c_0 l_1(\varepsilon+\alpha)t+$$

$$+h_1 f_0 c_1 l_1 e^{(\beta+\varepsilon+\alpha)t}+h_1 f_0 y_0(1-\phi)l_1 e^{(\varepsilon+\alpha)t}+h_1 f_0 y_1(1-\phi)l_1 e^{(\gamma+\varepsilon+\alpha)t}+h_1 f_1 c_0 l_1 e^{(\iota+\varepsilon+\alpha)t}+$$

$$+h_1 f_1 c_1 l_1\alpha e^{(\beta+\iota+\varepsilon+\alpha)t}+h_1 f_1 y_0(1-\phi)l_1 e^{(\iota+\varepsilon+\alpha)t}+h_1 f_1 y_1(1-\phi)l_1 e^{(\gamma+\iota+\varepsilon+\alpha)t}+h_1 n_0 l_1(\varepsilon+\alpha)t+$$

$$\backslash+h_1 n_1\alpha l_1 e^{(\delta+\varepsilon+\alpha)t}-n_0\alpha(1-\phi)h_1 l_0 e^{\alpha t}-n_0\alpha(1-\phi)h_1 l_1 e^{(\varepsilon+\alpha)t}-$$

$$-n_1\alpha(1-\phi)h_1 l_0 e^{(\delta+\alpha)t}-n_1\alpha(1-\phi)h_1 l_1 e^{(\delta+\varepsilon+\alpha)t}.$$

Hence, we group summands with the exponent equal powers and obtain the following:

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

$$+h_1 f_0 c_0(\alpha+l_0)e^{\alpha t}+h_1 f_0 y_0(1-\phi)(1+l_0)e^{\alpha t}+h_1 n_0(+l_0)\alpha t-n_0(-\phi)h_1 l_0\alpha t+$$

$$+h_0 f_0 c_1(1+l_0)e^{\beta t}+$$

$$+h_0 f_0 y_1(1-\phi)(1+l_0)e^{\gamma t}+$$

$$+h_0 n_1\alpha(1+l_0)e^{\delta t}-n_1\alpha(1-\phi)h_0 l_0 e^{\delta t}+$$

$$+h_0 f_1 c_0(1+l_0)e^{\iota t}+h_0 f_1 y_0(1-\phi)(1+l_0)e^{\iota t}+$$

$$+h_0 f_0 c_0 l_1\alpha e^{\varepsilon t}+h_0 f_0 y_0(1-\phi)l_1 e^{\varepsilon t}+h_0 n_0 l_1\varepsilon t-n_0(-\phi)h_0 l_1\varepsilon t+$$

$$+h_1 f_0 c_1(1+l_0)e^{(\beta+\alpha)t}+$$

$$+h_0 f_0 c_1 l_1 e^{(\beta+\varepsilon)t}+$$

$$+h_1 f_0 c_0 l_1\alpha e^{(\varepsilon+\alpha)t}+h_1 f_0 y_0(1-\phi)l_1 e^{(\varepsilon+\alpha)t}+h_1 n_0 l_1(\varepsilon+\alpha)t-n_0(-\phi)h_1 l_1(\varepsilon+\alpha)t+$$

$$+h_0 f_0 y_1(1-\phi)l_1 e^{(\gamma+\varepsilon)t}+$$

$$+h_0 n_1 \mathrm{å} l_1 \mathrm{e}^{(\delta+\ddot{e})t} - n_1 \acute{a}\,(1-\phi) h_0 l_1 \mathrm{e}^{(\delta+\ddot{e})t} +$$

$$+h_0 f_1 c_1 (1+l_0)\mathrm{e}^{(\tilde{a}+\hat{i})t} +$$

$$+h_1 f_1 c_0 (1+l_0)\mathrm{e}^{(\hat{i}+\ddot{a})t} + h_1 f_1 y_0 (1-\phi)(1+l_0)\mathrm{e}^{(\hat{i}+\ddot{a})t} +$$

$$+h_0 f_1 y_1 (1-\phi)(1+l_0)\mathrm{e}^{(\varsigma+\hat{i})t} +$$

$$+h_0 f_1 c_0 l_1 \mathrm{e}^{(\hat{i}+\ddot{e})t} + h_0 f_1 y_0 (1-\phi) l_1 \mathrm{e}^{(\hat{i}+\ddot{e})t} +$$

$$+h_1 f_0 y_1 (1-\phi)(1+l_0)\mathrm{e}^{(\varsigma+\ddot{a})t} +$$

$$+h_1 n_1 \mathrm{å}(1+l_0)\mathrm{e}^{(\delta+\ddot{a})t} - n_1 \acute{a}\,(1-\phi) h_1 l_0 \mathrm{e}^{(\delta+\ddot{a})t} +$$

$$+h_1 f_0 c_1 l_1 \mathrm{e}^{(\tilde{a}+\ddot{e}+\ddot{a})t} +$$

$$+h_1 f_1 c_1 (1+l_0)\mathrm{e}^{(\tilde{a}+\hat{i}+\ddot{a})t} +$$

$$+h_1 f_1 c_0 l_1 \mathrm{e}^{(\hat{i}+\ddot{e}+\ddot{a})t} + h_1 f_1 y_0 (1-\phi) l_1 \mathrm{e}^{(\hat{i}+\ddot{e}+\ddot{a})t} +$$

$$+h_0 f_1 y_1 (1-\phi) l_1 \mathrm{e}^{(\varsigma+\hat{i}+\ddot{e})t} +$$

$$+h_0 f_1 c_1 l_1 \mathrm{e}^{(\tilde{a}+\hat{i}+\ddot{e})t} +$$

$$+h_1 n_1 \mathrm{å} l_1 \mathrm{e}^{(\delta+\ddot{e}+\ddot{a})t} - n_1 \acute{a}\,(1-\phi) h_1 l_1 \mathrm{e}^{(\delta+\ddot{e}+\ddot{a})t} +$$

$$+h_1 f_1 y_1 (1-\phi)(1+l_0)\mathrm{e}^{(\varsigma+\hat{i}+\ddot{a})t} +$$

$$+h_1 f_0 y_1 (1-\phi) l_1 \mathrm{e}^{(\varsigma+\ddot{e}+\ddot{a})t} +$$

$$+h_1 f_1 c_1 l_1 \mathrm{e}^{(\tilde{a}+\hat{i}+\ddot{e}+\ddot{a})t} +$$

$$+h_1 f_1 y_1 (1-\phi) l_1 \mathrm{e}^{(\varsigma+\hat{i}+\ddot{e}+\ddot{a})t}.$$

Appendix 3

Initial Data for Modeling

The increment rates and sustainable growth trajectories (see Figures 1**Ошибка! Источник ссылки не найден.** and 2), the logistic sustainable growth trajectory (see Figure 7**Ошибка! Источник ссылки не найден.**) and the growth trajectory with a decline period (see Figure 8**Ошибка! Источник ссылки не найден.**) were modeled using the financial ratios indicated in Tables 1–3.

Table 1. Initial data for modeling the increment rates and sustainable growth trajectories

Ratio	Growth			
	with spread	without spread	catching-up	industry
B	0.7	0.7	0.2	0.7
S/A	1.5	1.5	1.5	1.5
M	20%	20%	10%	6%
Z	10%	0%	-5%	0%
Φ	22%	22%	22%	22%
J	9%	9%	9%	9%
E	0.7	0.7	0.7	0.7
D/E	1.0	1.0	1.0	1.0

Table 2. Initial data for modeling the logistic trajectory of sustainable growth

Ratio	$t = 0$	$t = \infty$
b	0.7	0.7
S/A	1.5	1.5
m	68%	0%
z	10%	0%
ϕ	22%	22%
j	9%	0%
ε	0.7	0.7
D/E	1.0	0.0

Ratio 3. Initial data for modeling the growth trajectory with a decline period

Ratio	$t = 0$	$t = \infty$
b	0.7	0.7
S/A	1.5	1.5
m	48%	-5%
z	10%	0%
ϕ	22%	22%
j	9%	9%
ε	0.7	0.7
D/E	1.0	1.0

The values of financial ratios correspond to the average levels, which emerged in 2001–2021. A company engaged in extraction of commercial minerals was the prototype. The share of debt with a free-floating interest rate α is taken to be equal to 100%. The cost of debt and inflation of manufacturing resource price correspond to general economic inflation.

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Assessing the Sustainability of Russian Iron and Steel Companies Amid a Structural Crisis

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Abstract

In the present paper the authors developed and tested the sustainability index of Russian iron and steel companies against the background of a structural crisis caused by the sanctions of 2022. Six companies with public reporting, including Nornickel and United Company RUSAL, were analyzed. The index comprises financial sustainability (Altman's Z-score), operation flexibility, strategic planning horizon, economic value added (EVA), as well as environmental and social aspects. It was established that companies that actively adapt such strategies as market and commodity diversification, supply chain management and environmental standard integration exhibit stronger sustainability. For example, Nornickel managed to redirect export from Europe to Asia, maintaining its financial stability despite a reduction in EBITDA by 17%. When RUSAL came up against supply chain disruption and an increase in costs, it recouped a part of losses by expanding in Asian markets and domestic operations. Practical recommendations based on the research comprise extending the planning horizon, reducing reliance on a single product or region and reinforcing the environmental and social sustainability. These conclusions confirm the hypothesis that companies that have gained experience in crisis management overcome new challenges with greater success.

Keywords: strategic sustainability, operational sustainability, financial sustainability, Altman's Z-score, economic value added, emerging capital markets, company's horizon, metallurgical industry, structural crisis.

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Introduction

The topic of corporate sustainability has gained popularity due to a large scale of the crises which have occurred over the recent years. The increasing complexity of the business environment and growing competition entails greater volatility of companies' operations. Besides, there is no common approach to measuring sustainability. The purpose of the paper is to solve the applied problem of tracing the Russian companies' sustainability during crises, especially against the background of macroeconomic events of 2022. In order to achieve our purpose, we: 1) analyzed academic literature dedicated to defining and measuring sustainability, economic profit, planning horizon and stability indices; 2) determined the business indicators of sustainability; 3) chose the sustainability evaluation method on the basis of analysis of various parameters; 4) defined the objects for a case study in the metallurgical industry; 5) created the sustainability index for Russian public companies; 6) assessed the influence of macroeconomic factors on the company's sustainability indicators; 7) provided recommendations for improvement of the company's standing in volatility periods.

The research objects are iron and steel companies: Mining and Metallurgical Company Norilsk Nickel, United Company RUSAL, PAO Magnitogorsk Iron and Steel Works, Mechel Group, PAO Severstal. Our case study places more attention on MMC Norilsk Nickel and UC RUSAL.

The research subject in our paper is the indicators that manifest the sustainability of Russian iron and steel companies with publicly available reports for 2022–2023.

Bloomberg and *Capital IQ,* as well as the data published by the companies that serve as research subjects, are the main data sources.

The research is performed by means of case study. This method was chosen because we wish to emphasize adaptation strategies in the circumstances of macroeconomic uncertainty. The paper is of practical significance since the case study results may be useful both for company managers and similar companies from the same industry, allowing them to assess their ability to adapt when macroeconomic volatility emerges.

Sustainability as a Company Management Component

Crisis and emergency situations have become an integral part of the present-day world and are one of the key factors that influence a company's operations and survival capability.

The researchers [1] believe that apart from outperforming their competitors in handling a recession and recovery, sustainable companies also accelerate their growth under new circumstances.

In a broad sense, sustainability refers to a company's ability to overcome crises without serious losses. In a narrower sense, sustainability is the capability to cope rapidly and efficiently with the effects of a crisis [2]. Traditionally, companies focus on financial indicators when considering sustainability. However, researchers from *McKinsey* [3] point out that, for example, due to climate changes companies have to adjust themselves to expectations of governments, shareholders and the society in general. Adaptation entails changes in the business model, so it is necessary to achieve sustainability and flexibility in a new context. Another example is when digitalization requires creation of a mechanism of mass cyberattack defense, which also causes changes in the business model.

These changes imply a broader view on sustainability and necessitate the measuring of its six parameters: finance, operations, technology (digitalization), company structure, reputation and business model.

Financial sustainability means that companies have to manage both long-term and short-term financial objectives efficiently.

Operational sustainability consists in the ability to respond to changes in demand when operating activity is impeded, i.e., to improve supply chains used to deliver the materials necessary to manufacture products, as well as the finished products to consumers.

Technological (digital) sustainability consists in avoidance of faults in technological chains, ensuring cybersecurity, etc.

Organizational sustainability means the company's ability to foresee and respond to events by means of adaptation to them and natural recovery, aligning the structure with business goals.

Reputational sustainability consists in company's capability to maintain or improve its image in the partners' and consumers' opinion. If a company determines its mission correctly it meets public expectations and handles criticism easier.

Business model sustainability is the ability to adapt to significant changes in a competitive environment.

In addition, some researchers also consider **strategic sustainability**.

As noted in the studies by *McKinsey* [4], companies already address sustainability ensuring the following:

- Balance sheet restructuring, i.e., an increase in the debt that a company may service under stress in order to enhance the credit rating.
- Analyzing the supply chain to detect the suppliers that involve high risk and expenses in order to achieve operational sustainability.
- Fixed asset decarbonization as part of sustainable development integration along the value chain in the core business.
- Using a crisis as a growth opportunity. For example, disruption of supply chains and rendering services during COVID-19 resulted in offering services via virtual channels.

Sustainable companies apply several methods to deal with a crisis – foresight, response and adaptation.

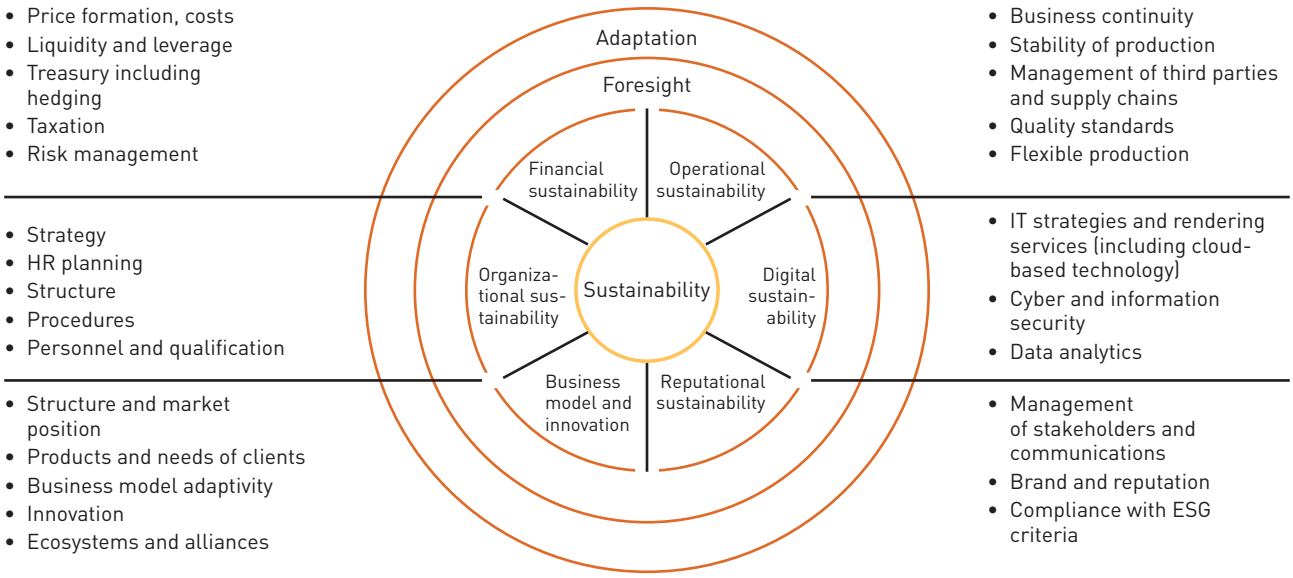
Foresight (scenario analysis) consists in creating hypothetical scenarios (for example, technology breakdown or market crash) followed by the evaluation of the potential impact on business and sustainability. Such analysis may offer geographic diversification as a solution in order to reduce dependence.

A response, i.e., a possibility to solve the encountered problem quickly and effectively, paves the way for a company's success.

Adaptation is the company's capability to avail of growth opportunities in unfavorable conditions.

The key sustainability factors may be presented as a matrix (Figure 1).

Figure 1. Key factors of corporate sustainability



Source: [1, p. 10].

In order to make the company sustainable, it is necessary to construct a crisis response strategy and develop a number of scenarios, using which companies may test their capital structure and cash flows. Such actions may assist in overcoming the recession without losses and purchasing assets during crises at lower prices.

Composite Sustainability Index of an Iron and Steel Company

Definition of the Index Components and Calculation Methodology

On the basis of literature analysis [5–7], we decided to use the following parameters for the composite sustainability index (each parameter will be assigned a value from 1 to 3): 1) planning horizon; 2) economic component; 3) efficiency; 4) flexibility; 5) environmental and social components of the industry.

1. Planning Horizon as a Sustainability Indicator. Strategic planning of a company is a determining factor in building a sustainable company because it defines the company's development trend, besides, the strategies may be either long-term or short-term. To assess the efficiency of the chosen strategies, the McKinsey Institute performed a study based on the data on 615 US public companies in 2001–2015 by means of constructing the index that showed the investment level, growth rates, quality of profit and their management [8].

On the basis of the McKinsey methodology, Russian authors calculated the index of a company's strategic planning horizon according to four parameters [5] as at a certain date, as well as their industry average. Then they compared the index value of a certain company to the industry average value (Table 1). To ensure the validity of the results, the companies were compared only to their industry peers.

Table 1. Financial indicators used in index calculation

Factor	Formula	Description
Investment	Capital expenditures$_t$ / Depreciation$_t$	Companies with a long-term planning horizon invest resolutely and in larger amounts

Factor	Formula	Description
Quality of profit	(Net profit$_t$ – Free cash flow$_t$) / Revenue$_t$	Ratio of accrued future income to revenue
Profitability growth	Revenue$_t$ / Revenue$_{t-1}$ – Net profit$_t$ / Net profit$_{t-1}$	Difference between growth of revenue and net profit
Earnings per share	Net profit$_t$ / Net profit$_{t-1}$ – Earnings per share$_t$ / Earnings per share$_{t-1}$	Difference between growth of net profit and the indicator of net earnings per share

Source: [5, p. 475].

The formula for the index is as follows:

$$CHI_{average}^{IndustryX} = \frac{\sum_{i=2016}^{2023}\left(Factor1-4_i^{Industry\ X} * 25\%\right)}{number\ of\ companies\ in\ industry\ X}. \quad (1)$$

Calculation of the index provides an opportunity to classify companies as "far-sighted" (i.e., using a long-term strategy) or "short-sighted" (i.e., using a short-term strategy).

2. The Economic Component of Sustainability. To assess this component, a five-factor Altman's Z-score was used [7]. The results offered by this model allow to analyze financial strategies. The model formula is as follows:

$$Z = 0{,}717X_1 + 0{,}847X_2 + 3{,}107X_3 + 0{,}42X_4 + 0{,}998X_5. \quad (2)$$

Description of the formula components is presented in Table 2.

Table 2. Key coefficients of the Altman's Z-score

Coefficients	Components	Description
X_1	NWC$_t$ / TA$_t$, where NWC$_t$ – net working capital as at the end of period t; TA$_t$ – company assets as at the end of period *t*	The coefficient is of importance in defining liquidity; a decrease in net working capital as compared to assets often occurs in the companies with weakening financial sustainability
X_2	RE$_t$ / TA$_t$, where RE$_t$ – undistributed profit for period *t*	The higher this coefficient, the more opportunities the company has to develop products and projects inside the company
X_3	ROA$_t$ = EBIT$_t$ / TA$_t$, where EBIT$_t$ – earnings before interest and taxes	The coefficient is indicative of efficiency of management decisions in relation to corporate asset management
X_4	Equity$_t$ / Debt$_t$, where Equity$_t$ – book value of equity as at the end of period *t*; Debt$_t$ – book value of debt capital as at the end of period *t*	The lower the financial leverage of the company (the indicator is higher), the lower the probability that the company will encounter difficulties with financial sustainability caused by credit payments
X_5	S$_t$ / TA$_t$, where S$_t$ – company revenue for period *t*	The indicator shows asset turnover

Source: [7].

The value of the Altman's Z-score below 1.23 is indicative of a low level of corporate financial sustainability. The range of 1.23 to 2.9 manifests moderate financial sustainability. A value exceeding 2.9 shows high financial sustainability.

To analyze the financial sustainability of large Russian businesses, we offer the following parameter ranking:

- change for the worst (value 1);
- absence of changes (value 2);
- change for the better (value 3).

3. Company Efficiency as a Component of Sustainability. In general, economic value added (*EVA*) is closely related to business resilience. The companies that generate consistently positive *EVA* are usually more sustainable and better prepared to prosper in a dynamic and complex business environment.

To evaluate the dynamics of the company status, we construct the financial strategies matrix.

So, we have to calculate the indicators presented in Table 3.

Table 3. Indicators of the financial strategies matrix

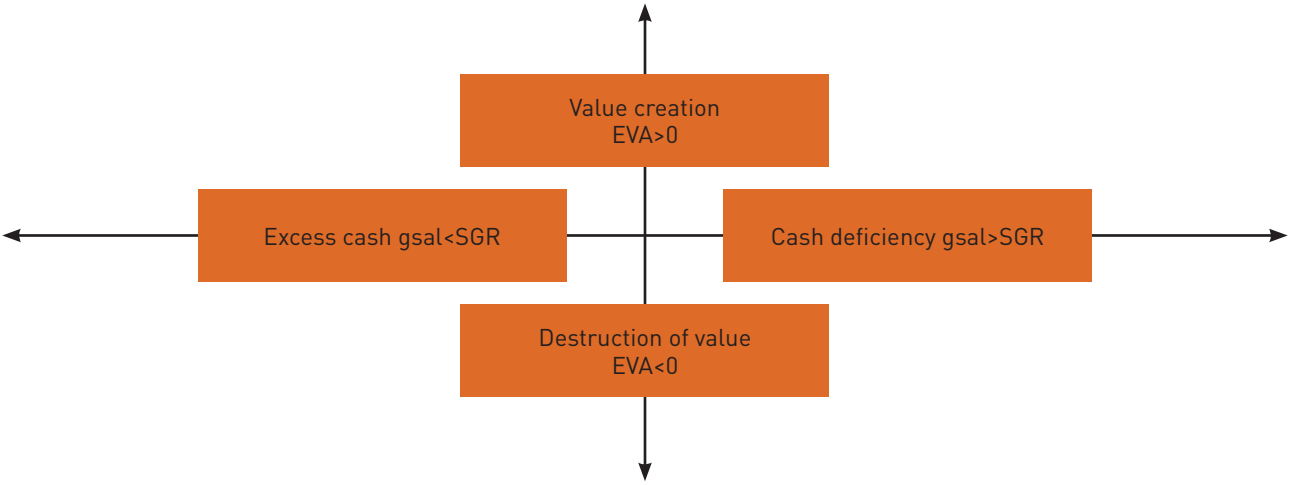
Indicators	Designation	Calculation
Return on equity	*ROE*	Net profit / Equity
Rate of return	*RR*	(Net profit – Dividends) / Net profit
Sales growth rate	*Gsal*	Forecasting/Actual when there is no forecast
Sustainable growth rate	*SGR*	*RR•ROE*
Spread	*Spread*	*Gsal-SGR*

Source: [9].

Analysis of the matrix provides an opportunity to determine the possible areas for business development. If a company is located in the upper right quadrant, it is recommended to reduce dividends or raise additional capital; in the lower right quadrant – to consider changing the strategy and perform business process reengineering; in the lower left quadrant – to use excess cash to improve profitability and/or reconsider the capital structure, in the upper left quadrant – to use excess cash to accelerate growth or repurchase the company's own stock/pay dividends to the owners.

The matrix is presented in Figure 2.

Figure 2. Matrix of corporate financial strategies



Source: [9].

We offer the following ranking of the results:

- the company has aggravated its position (value 1);
- the company's position has not changed (value 2);
- the company improved its position (value 3).

4. Strategic Flexibility as a Component of Sustainability. It allows to take into consideration the efficiency of decision-making related to the functioning of an entire group of companies and implementation of fresh capacities (capital investment). We propose to add several components to this parameter, the average value of which will be the parameter value.

1) capital expenditures/revenue:

- the indicator is below the sample average (value 1);
- the indicator equals the sample average (value 2);
- the indicator exceeds the sample average (value 3);

2) revenue diversification:

- regional revenue is over 75% of the consolidated revenues (value 1);
- regional revenue is over 50% and less than 75% of the consolidated revenues (value 2);
- regional revenue is less than 50% of the consolidated revenues (value 3).

3) diversification of revenue by product:

- the share of the product is over 75% of the consolidated revenues (value 1);
- the share of the product is over 50% and less than 75% of the consolidated revenues (value 2);
- the share of the product is less than 50% of the consolidated revenues (value 3).

The values of the product and geographical diversification parameters for Magnitogorsk Iron and Steel Works (MMK), Mechel and Severstal in 2022–2023 were assumed to be equivalent to the value calculated in 2021 because information was unavailable.

5. Environmental and Social Industry-Related Components of Sustainability. Amid a structural crisis or introduction of sanctions, integration of the environmental and

social components into the crisis sustainability index becomes crucial.

In order to evaluate sustainability from the environmental point of view, we are going to use indicators from reports made according to *GRI*. It comprises the tracing of eight key indicators: raw materials; energy; water; biodiversity; emissions; sewage and wastes; environmental compliance; environmental assessment of the supplier [10]. In most cases, the quantitative evaluation of these indicators and their comparison between companies is impeded because the necessary information is only partly available from official sources. Therefore, in the absence of sufficient empirical data to evaluate sustainability of industrial companies, the score-based evaluation method is often applied [11].

Sustainability from the social point of view is, in the first instance, assessed against staff turnover, which may increase during a crisis or sanctions due to uncertainty in the labour market and changes in the workplace environment. We offer the following ranking of staff turnover:

- above the industry average (value 1);
- equal to the industry average (value 2);
- below the industry average (value 3).

We use the value of 2022 for staff turnover in 2023 because there is no data.

The index will be calculated on the basis of the abovementioned sustainability parameters by the geometric mean formula according to the existing methodic practice [12]:

$$I_R = \sqrt[5]{HI \cdot Alt \cdot EVA \cdot I_{Strategy} \cdot I_{ES}}, \quad (3)$$

where I_R – the composite sustainability index of an iron and steel company; *HI* – company horizon; *Alt* – value of the parameter of the five-factor Altman's Z-score; *EVA* – dynamics of the position in the financial strategies matrix (see Figure 2); $I_{Strategy}$ – strategic component of sustainability; I_{ES} – environmental and social component of sustainability.

Characteristics of the Russian Companies' Sample

The sample of iron and steel companies comprises the data which has been uploaded from the *Bloomberg* and *Capital IQ* analytical databases and also obtained from companies' consolidated statements. Based on the sample, we calculated the values of the five-factor Altman's Z-score, economic profit, planning horizon index, strategic and environmental components of sustainability.

The sample comprises the following companies:

- Mechel is one of the largest Russian companies engaged in coal mining and conversion, as well as in production of steel and other metallurgical products. The company holds a significant share in the coal and metal market; however, it faces financial and operational challenges, including a high debt ratio.
- Magnitogorsk Iron and Steel Works (MMK) is one of the global leaders in the iron and steel industry. Iron and Steel Works specializes in the manufacture of a wide range of steel products including hot-rolled, cold-rolled, zinc-coated and varnish-and-paint sheets, pipes and other articles.
- Mining and Metallurgical Company Nornickel is one of the leading global manufacturers of nickel, palladium, platinum and copper. The company makes a significant impact on the global market of metals and products of metal processing and ranks among the key players in the industry.
- United Company RUSAL is one of the largest global aluminum manufacturers with assets all over the world, including Russia, North and South America, Europe and Asia. It specializes in bauxite mining (raw materials for aluminum production), manufacture of rolled aluminum, aluminum alloys and other products.
- Severstal is a large Russian manufacturer of steel and steel products, including rolled sheet, profile and pipes. The company owns assets in Russia and abroad.

All the above companies are the leaders in their sector with public reporting available up to and including 2021 (not all of them disclosed information in 2022).

For the case study we are going to consider the two largest public players of the Russian iron and steel market: MMC Norilsk Nickel and United Company RUSAL.

3.Case Study: Sustainability of Russian Companies and Adaptation Strategies against the Background of Crisis

Results of the Composite Index Construction

Analyzing companies' sustainability according to several parameters, we constructed a composite index that comprises financial, economic, strategic and environmental indicators. Analysis of pre-crisis data allowed to assess historical dynamics and the level of preparedness of companies to possible operational instability caused by sanctions in 2022.

As a result of the performed analysis, we created the sustainability index as at the end of 2021, which is a combination of the factors indicative of a company's capability to maintain sustainability during a structural crisis.

According to the obtained index, Mechel is in the least favourable position, while Severstal has the highest index value as at the end of 2021. For further analysis we chose RUSAL and Nornickel premised on data availability for 2022.

Case Study Hypotheses

Based on the analysis of the iron and steel industry in Russia, as well as financial and operational analysis of Nornickel and RUSAL, we may suggest the following hypotheses:

Hypothesis 1: In the midst of a crisis, sustainability may be enhanced because the company avails of the opportunities emerging in periods of uncertainty.

Hypothesis 2: More sustainable companies lose less of their estimated sustainability value during a crisis than less prepared ones.

Hypothesis 3: Antecedent sanctions pressure on the company enhances the likelihood of applying response strategies in case of subsequent challenges.

Sustainability Indicators as Exemplified by UC RUSAL

In 2022–2023 UC RUSAL faced a lot of challenges, which forced the management to change the business model. Negative changes are as follows: disruption of production and commodity chains; lower availability of imported raw materials and equipment; changes in the target markets, demand fluctuations and increasing cost of production.

According to the index, since 2021 the company's sustainability decreased, however, it remained above the values of 2020 due to, among other things, the prompt measures that transformed the supply chains (Table 4), as well as target market extension. The general negative influence of sanctions and core product's (aluminum) price volatility resulted in reduced indicators [13].

Table 4. RUSAL revenue diversification

Revenue by types of products, %	2017	2018	2019	2020	2021	2022	2023
Aluminum	85	82	84	84	85	85	85
Alumina	15	18	16	16	15	15	15
Total, %	**100**	**100**	**100**	**100**	**100**	**100**	**100**
Revenue by regions, %	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**
Europe	42	47	49	42	37	36	28
Asia	24	29	27	29	33	29	32
Americas	17	10	8	7	9	7	1
Russian Federation and CIS	16	14	14	21	21	27	38
Total, %	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Source: [13]

Among other things, the company determined the following risks for itself, taking into consideration the considered structural crisis:

1) hard-to-predict change in demand for virgin metal and alloys due to the sanctions and trade restrictions imposed on a range of Russian industries;
2) loss of company's control over foreign assets and tightening of restrictions;
3) rise in the prices for transportation services caused by disruption of global supply chains, sanctions restrictions;
4) inability to supply and/or repair equipment and components due to sanctions restrictions, resulting in suspension of operations.

To analyze strategic measures, we propose to consider the factors that influenced the index components and their current value (in 2022–2023). As for the first index component –Altman's Z-score – there are no significant changes; the company retains the financial sustainability level achieved in 2021. Besides, the company's revenue in 2023 dropped by 13% after an increase by 17% in 2022. Discontinuation of alumina production at the Nikolaev Alumina Refinery disrupted the company's usual supply chains. However, RUSAL management succeeded in promptly reorganizing the raw materials delivery and supply chains redirecting the flows to the domestic and Asian markets, thus preserving the aluminum sales volume at the 2021 level. In October 2023 the company signed an agreement for the purchase of a 30% stake in a Chinese iron and steel company, thus ensuring access to a stable source of alumina. Therefore, RUSAL is looking for new ways to save on imported raw materials, including company acquisitions in friendly countries, and sets a goal to ensure strategic security [14].

The company's operating profit decreased by 41%, and the net profit – by 44%. It was caused by a rise in price for energy commodities and raw materials. Additionally, alumina purchase costs grew mainly due to an increase in the cost price. The factors that influenced the corporate operating results led to a decrease in the operating income margin.

In 2023, the company continued to focus on reorganizing logistic routes, developing the domestic market, and implementing sustainability programs. At the same time, the annual company revenue dropped by 12.6%, up to $12 bln due to a decrease in the price for aluminum in the London Metal Exchange (*LME*) by 16,8%. Revenue from sales of alumina and foil reduced for the second year running (by 38.2% and 5.3%, respectively), while purchase prices of raw materials (except for alumina and bauxites) and electrical energy decreased by 20% and 14%, respectively [15].

According to our calculations, the company's economic value added decreased in 2022 and continued to decrease in 2023 as a result of both reduced cash flow from operations and an increased weighted average cost of capital. In 2022, the company moved to the left part of the financial strategy matrix, which represents excess cash because it practically did not pay out dividends and had ROE of 16%, while revenue showed almost no growth. However, when in 2023 revenue grew by 14% with ROE of 2%, the company showed cash deficiency. Based on the company's

current position in the financial strategies matrix, it is recommended to reengineer its business processes in order to improve EVA. Excess cash in 2022 was a result of low growth rates caused by sanctions.

Inasmuch as no sanctions were imposed on the company, in 2022 RUSAL continued deliveries to Europe (revenue +13%) and America (revenue –5%) and simultaneously increased its revenue in Asia by 53%. However, in 2023 revenue in Europe dropped by 32%, in America – by 83%, and continued to grow in Asia (25%). Due to the specific nature of its business, the company is focused on a single product and depends completely on this product's price fluctuations.

In the challenging 2022, staff turnover remained at the 2021 level because the company promotes a social policy aimed at improving employee welfare and working environment. In 2022, as part of professional development and vocational training, 27,000 employees were trained both in internal programs and by external providers and experts.

As for environmental issues, the company continues to disclose and assess the parameters considered in *GRI*, and openly demonstrates the results and plans of its environmental and climate activities. In 2022, the Board of Directors adopted a revised environmental policy, which sets out that RUSAL will focus on land reinstatement, promote preservation of biological diversity and complete the carbon-neutral transition by 2050.

The company implements a long-term program for updating the process control systems in order to reduce electric energy and raw materials consumption. For this purpose, automated systems are designed. Also, development is performed using Russian platforms as part of imports phase-out. Additionally, the company benefited from the sanctions imposed in 2018, and in 2021 it began to use mainly Russian equipment for its plants when constructing Boguchansky Aluminum Smelter in the Taezhny settlement in the Krasnoyarsk Region.

In 2022, the company increased its revenue, unlike Nornickel, but in 2023 its revenue declined. The fluctuations are largely caused by the aluminum price volatility. It is recommended to take note of low capital expenditures relative to depreciation, as well as revenue, whose growth rate is lower than the profit growth rate.

Thus, in 2022, company sustainability was enhanced due to the change of the position in the financial strategies matrix (the company moved to the excess cash area by means of higher net profit growth rates). According to financial statements, in the five-factor Altman's Z-score the value of sustainability decreased, approaching the threshold but not crossing it. From the strategic point of view, the company faced difficulties, but managed to redirect commodity flows and circumvent restrictions.

Sustainability Indicators as Exemplified by MMC Norilsk Nickel

In the annual report for 2022, the management of MMC Norilsk Nickel noted that the company had already recovered from the effects of the COVID-19 pandemic and work-related incidents at the Taimyrsky and Oktyabrsky mines. Nevertheless, the sanctions imposed in 2022 produced a significant negative impact on business because the company had to elongate its supply chains and switch to new target markets. The company redirected commodity flows: the share of the European region in its revenue decreased from 47 to 24%, while the share of the Asian region grew from 31 to 53%. The company's EBITDA dropped by 17%, down to $9 bln, as a result of a decrease in consolidated revenue by 5%, down to $17 bln, and the price rise caused by increased staff and repair costs [16].

Thus, for example, the amount of ore produced by Kola MMC was 2% (7 mln tons) less than in the previous year, which is directly related to the sanctions restrictions: insufficient amount of self-propelled diesel equipment, lack of spare parts for it and stoppage of maintenance service of mining machinery in Russia by western companies (Table 5).

Table 5. Diversification of Norilsk Nickel revenue (%)

Revenue by type of product	2017	2018	2019	2020	2021	2022	2023
Europe	54	52	45	45	53	47	24
Asia	27	25	35	35	27	31	53
North and South America	15	18	16	16	15	15	10
Russian Federation and CIS	5	5	4	4	4	8	12
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**
Output plans	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**
Nickel, thousand tons	217	217	217	233	190	219	204
Platinum group, mln oz	3,5	3,5	3,5	3,5	3,2	3,5	3,0
Copper, thousand tons	457	457	457	487	407	453	417

Source: [16].

Besides, company debt increased by 12%, up to $12 bln as a result of refinancing when the external factors deteriorated. At the same time, the National Rating Agency Expert RA confirmed the company's credit rating at the highest investment level of ruAAA.

On 29 June 2022, the UK imposed personal sanctions on Vladimir Potanin, however, the sanctions are not applied to the company (some contracting parties may reconsider their relationship with the company in order to comply with the restrictions concerning interaction with Russian legal entities).

Historically, financial stability was characteristic of Nornickel, and it is confirmed by the past values of the Altman's Z-score model. This long-term trend also manifested itself during the crisis – the company's position did not change for the worse because it maintained its financial indicators (for example, working capital) at the same level. Besides, in 2022, company revenue dropped by 10%, up to $16.1 billion. The company EBITDA margin lowered by 7% (to 52%), thus, combined with the revenue decline, reducing EBITDA by 17%, to $8.7 bln. In spite of the changing dynamics in the target markets, in 2022 the company boosted the manufacturing of its core products.

In 2022, the company's economic value added decreased by 33%, up to $2.9 bln, and in 2023 – by 54%, up to $1.3 bln. The reason is a simultaneous increase in the weighted average cost of capital (WACC) and a decrease in the return on invested capital (*ROIC*). The first factor may be explained by an increase in the risk-free rate represented by the yield on 20-year Federal Loan Bonds, growth in the sector's unlevered beta and borrowed capital's cost increase. In its turn, *ROIC* decreased as a result of a reduction in *NOPAT*. Based on the financial strategies matrix, the company is recommended to allocate cash aiming at accelerating revenue growth and redemption of stock/dividend payout. Given that company revenue decreased as a result of the sanctions restrictions we propose to apply funds towards restoring sales channels and increasing revenue [16].

Unlike RUSAL, the company is less exposed to price risks because it has multiple partners in various regions and industries due to its diversified product range.

In 2022, staff turnover decreased by 1% (up to 11%), which is indicative of the company's ability to retain employees. As part of the training strategy for 2022-2025, Nornickel defined the creation of an ecosystem of proactive training for personnel development as one of its important goals. At the same time, the company regularly holds events aimed at the implementation of its corporate programs (65,500 employees have taken courses in digital skills development), it has expanded the area of its corporate university and implements a set of measures intended to support employees when they move to another region.

The company also addresses other aspects of social development – corporate culture development – by means of promoting volunteering activities and involvement, labor compensation, which comprises a comprehensive employee motivation system, it cooperates with trade unions, has operating social councils and maintains sports, medical, and housing programs, and pension plans. The company is committed to a zero-tolerance policy in relation to industrial injuries. This decreases the number of fatal cases and lost time incidents.

In the sphere of climate development, the company reveals and monitors numerous parameters in compliance with the environment management system. In general, it achieved improvements, such as reduced carbon dioxide emissions and sewage discharge into water bodies, and maintained biodiversity.

Following its risk management strategy, Nornickel considers imports phase-out a factor protecting from the risks related to equipment and services supply by foreign vendors. In particular, the company is highly interested in the use of Russian technology solutions, so it selects, tests and implements them. For instance, Nornickel cooperated with the First Bit team and *PIX Robotics* vendor to phase out the imported software robots in the *UiPath* platform, preserving functionality.

Additionally, as part of managing this risk, the company actively engages Russian manufacturers in order to expand the competitive environment, signs long-term agreements that lock in the best prices for materials, determines critical suppliers and monitors the state of their activity.

Some western engineering companies and equipment suppliers terminated agreements, including the ones for performance of works under the comprehensive Sulphur Program project at the Copper Plant. The company intensively searches for import substitution solutions for this project. The company's investment program implies investing over RUB 2 trillion in asset development and modernization.

According to the planning horizon, it was historically characteristic of the company to use long-term planning, however, in 2021 the company was characterized as implementing short-term planning. In this case, it is recommended to pay attention to the growth rate of revenue relative to net income, as well as the *EPS* growth rate, which exceeds the net income growth rate. Besides, after the main phase of the crisis, the company switched its focus to the long-term horizon.

Within the observation period, according to financial statements, the sustainability value in the five-factor Altman's Z-score decreased and approached the threshold without crossing it. In 2022, the company increased its debt, similar to the companies from *McKinsey* studies [17]. The company partially changed its supply chains, however, as long as its products are in demand, no volume-related restrictions were applied in the form of sanctions. At the same time, the company's revenue decreased as a result of price fluctuations. Sustainability remained at the pre-crisis level.

The research results are presented in Table 6.

Table 6. Research results

Hypothesis	Result
1. In the midst of a crisis sustainability may be enhanced because the company avails of the opportunities emerging in periods of uncertainty	Nornickel managed to adapt to the emerging difficulties and redirect rapidly the flows to Asia. This, together with creation of economic value and financial sustainability, resulted in enhancement of general sustainability. The hypothesis is confirmed
2. More sustainable companies lose less of their estimated sustainability value during a crisis than less prepared ones	Based on the overall sample and case study it was revealed that each company has its own vector of development, and comparison of dynamics of indices may be misinterpreted due to the multifactorial nature of the parameters it comprises. The hypothesis is not confirmed
3. Antecedent sanctions pressure on the company enhances the likelihood of applying response strategies in case of subsequent challenges	Using RUSAL as an example, we considered the adaptation on the basis of past experience: elimination of foreign companies, which may withdraw services because the company had already faced restrictions when sanctions were imposed on it, from the list of suppliers. The hypothesis was confirmed

Conclusion

In our research we assessed the sustainability of Russian iron and steel companies, developed the sustainability index, considered in detail the index components as exemplified by case study of the leaders of the metallurgical sector. The probability of use of the development index for other industries is evaluated. The following theoretical and practical conclusions have been made.

We also considered various sustainability concepts. As a result of the analysis, sustainability was defined as the ability to cope with crises without significant losses and recover within an optimal period. Besides, the indicators that may determine sustainability and the ways to create it in a company were identified.

We have analyzed empirical studies by *McKinsey,* which show that sustainability is of importance, that sustainable companies demonstrate high performance during market volatility periods and macroeconomic shocks.

For the purposes of group analysis of the developed index, the sample comprised data about five companies for 2017–2023. We considered the five-factor Altman's Z-score, economic value added, which was used to construct financial strategy matrices for case study, environmental and social factors, corporate strategies of product and target market diversification as well as the company horizon.

We chose case study as the most suitable research method taking into account the specifics of our goal.

The influence of sanctions imposed during 2022–2023 and affecting the considered companies was pointed out. Companies' operations were considered over a period of time in order to analyze negative events and companies' adaptation to them, changes in supply chains, imports phase-out etc.

Recommendations were provided regarding possible strategic solutions based on the evaluation of economic profit and elongation of the planning horizon. Other index components which are to be taken into consideration when assessing company sustainability were pointed out.

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The Mediating Effect of Access to Capital in the Impact of Financial Literacy and Financial Inclusion on SME Sustainability

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Abstract

This study aims to examine the mediating role of access to capital in the impact of financial literacy and financial inclusion on SME sustainability. The object of the study is SMEs in Bali operating in the fashion sector. The total sample consisted of 277 SME leaders. Data was collected using a questionnaire tested with PLS-SEM. The results showed a significant and direct influence of financial literacy and financial inclusion on access to capital. Meanwhile, neither financial literacy nor financial inclusion by itself has a significant effect on SME sustainability. Only access to capital has a significant impact on SME sustainability. However, our findings show that access to capital can play a significant role in mediating the impact of financial literacy and financial inclusion on SME sustainability. In the context of SMEs, the results of the current study will be of particular interest to businesses focusing on fashion, showing that access to capital is an essential pillar in addition to financial literacy and inclusion. Access to capital is used as a mediating variable in the model for SME sustainability, whereas previous papers only focused on the influence of financial inclusion and financial literacy on SME sustainability. Including access to capital provides greater research insight. Our results show that, to develop, SMEs must foster financial management and instill technological knowledge to facilitate access to information on financial institution services.

Keywords: access to capital, financial literacy, financial inclusion, SME sustainability

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Introduction

The rapidly developing economies and high profitability of emerging markets provide opportunities for small and medium enterprises (SMEs) to become more competitive in domestic and global markets [1; 2]. Strong SMEs can support holistic national industrial development [3]. SMEs are able to drive the inclusive growth of the gross domestic product (GDP) [4], as well as contributing to wealth distribution, job creation, value-added productivity, technological progress, poverty reduction, innovation, and the social safety net [5–7]. The development of SMEs in Indonesia initially experienced stagnation yet became more successful after weathering various obstacles, including a monetary crisis [8]. However, SMEs in developing markets still face many difficulties such as inadequate banking financial facilities, limited capital, suboptimal financial knowledge, and insufficient capacity to explore new financial products [9]. In particular, weak financial literacy is a problem for SMEs in more developed financial markets, making it necessary for regulators to elaborate and evaluate financial literacy policies. Financial literacy refers to the ability of SMEs to apply financial products available in the market for making appropriate financial decisions [10]. Financial literacy should be seen as a fundamental aspect and universal need rather than a privilege of a small number of consumers with access to financial knowledge [11]. To overcome this problem, many institutions are working to provide maximum financial facilities to help SMEs improve and develop [12].

So far, SMEs in emerging markets have lacked financial management skills, which has had a serious impact on SME sustainability. Cowling et al. [13], Fraser et al. [14], and Lusardi [15] reveal that the financial crisis experienced by some countries in the past decade has increasingly disrupted the flow of debt and equity to SMEs. Sahibzada & Mumtaz [16] explain that there is a growing interest in the knowledge-based view (KBV) of organizational performance. KBV is a company strategy for achieving competitive advantage [17]. KBV can improve organizational performance by pooling collective knowledge resources [18]. The KBV concept also emphasizes the need for a company to integrate individual intellectual and organizational knowledge into its products and services. Organizations with large resources tend to obtain knowledge by observing their competitors. From the sustainability perspective, knowledge is a vital resource that is difficult to transmit socially [19; 20]. In particular, there is still little discussion about the use of knowledge resources to stimulate SME performance.

The manufacturing industry is a key sector of economic development. One of the commodities in demand by generations of consumers is fashion. In the past, fashion was seen as a luxury item intended only for select groups. In fact, fashion is not only a necessity but also part of the individual lifestyle, which allows people to choose a clothing style according to the latest fashion. The majority of Indonesian SMEs in the fashion sector manufacture creative and innovative products [21]. The fashion industry, especially accessories, dominates the Indonesian market, becoming a new domestic economic force that is driving the creative economy. In 2023, the Cooperatives, Small and Medium Enterprises Service of Bali Province [22] reported that there was a total of 439,382 SMEs in Bali Province, divided into the following four groups: 258,896 sales enterprises (58.9%), 73,641 agricultural industrial enterprises (16.8%), 67,102 non-agricultural industrial enterprises (15.3%), and 39,743 service enterprises (9%). In this classification, fashion SMEs are ranked as sales and service enterprises. Bali Province has 154,227 fashion SMEs, which represent 51.6% of the total number of sales and service SMEs. Fashion SMEs, which are mostly in the clothing sales cluster, offer products that are not only functional but also decorative, indicating the individual's social rank or status. Developments in the fashion sector are often presented in fashion shows at festivals and competitions. The fashion trend in Bali is influenced by modernization, the culture of other countries, and new technologies providing rapid access to information. In general, fashion SMEs are highly dependent on the available resources, including raw materials [23].

Financial literacy allows entrepreneurs to manage risk through different strategies such as maintaining financial reserves, diversifying the investment portfolio, and purchasing insurance. Financial literacy is rightly considered as one of the main factors of SME sustainability [24]. Mabhanda [25] identifies the lack of financial literacy as a common difficulty for SMEs. Poor financial literacy impacts budding enterprises as well as being one of the primary causes of SME failure [26]. Although the importance of financial literacy has been proven empirically, few studies have treated the impact of financial literacy and financial inclusion on SME sustainability. According to the dual process theory (DPT) in financial decisions, individuals with high financial literacy are influenced by intuition and cognitive processes. Nohong et al. [27] shows that financial literacy helps individuals (in this case, entrepreneurs) to take advantage of competitive financial markets by applying risk management skills they understand. Lusardi & Mitchell [28] and Reich & Berman [29] explain that financial literacy allows managers to address the root of the problems they are facing, enabling their SMEs to respond to uncertainty in business and financial markets. Generally speaking, financial literacy has both a direct and an indirect effect on the sustainability of SMEs [30]. In many developed countries, the SME sector views financial literacy as a foundation for fostering sustainability [31].

The research goal of the present study is to investigate the interaction between financial literacy, financial inclusion, and access to capital in the fashion SME sector. Both financial literacy and financial inclusion are predicted to have a direct influence on both access to capital and SME sustainability, as well as influencing SME sustainability indirectly through access to capital. Our results provide new insights into the mechanisms of access to capital as a driving force of SME sustainability alongside financial literacy and fi-

nancial inclusion. Good financial literacy and financial inclusion make it easier for fashion SMEs to gain access to capital.

Literature Review and Hypothesis Development

In the literature, financial literacy is articulated as cognitive abilities and knowledge in managing finances and making decisions for resolving financial problems [32]. Financial literacy represents the individual's ability to make effective assessments and funding decisions [33]. For entrepreneurs, financial literacy is a key skill. SMEs draw upon financial literacy for evaluating financial affairs and making financial decisions. Financial literacy helps them to address challenges and benefit from opportunities in the credit market. Johan et al. [34], Mitchell & Lusardi [35] and Nahar et al. [36] highlight that individuals with poor education or knowledge are unable to design sound financial policies or obtain access to credit services. Although there are questions regarding the effectiveness of financial education in increasing financial literacy, a positive relationship exists between financial knowledge and access to credit [37]. Financial knowledge can increase the chances of success in obtaining capital loans [38]. This leads to our first hypothesis:

Hypothesis 1: *Financial literacy affects access to capital.*

One measure of organizational skill is the ability to manage resources [39]. The availability of strategic resources such as access to financing influences the decisions made by managers. Financial inclusion provides opportunities for SMEs to improve their standing [40] and for financial service providers to offer services, gain profits, and attract new customers. Financial inclusion does not mean that companies must utilize the available resources or that providers should ignore risks and other costs when offering services but only refers to conditions where financial services are available to those who need them through affordable fee schemes [41]. The level of financial literacy of SME owners and its influence on demand for financial services, where although the literacy of SME owners has a relatively simple financial management structure, financial literacy plays a role in supporting the use of financial services [42]. In line with these findings, financial literacy can help SMEs to gain access to capital [43; 44]. Thus, we formulate our second hypothesis as follows:

Hypothesis 2: *Financial inclusion affects access to capital.*

The resource-based view (RBV) emphasizes that organizational value and competitive advantage depend on physical and non-physical resources [45]. Companies need a variety of complex knowledge resources to maintain competitive advantage [46]. Intellectual capital is positively related to organizational sustainability [47]. According to the KBV approach, financial literacy is a source of knowledge that determines SME sustainability. Technically, financial literacy is key in the value creation process for SMEs, ensuring their sustainable performance [48].

Some studies conclude that the relation between financial literacy and organizational value is positive [49–52]. Companies with a good level of financial understanding are able to adapt to strategic problems in the financial sector to maintain their performance [53]. Financial literacy is a vital instrument for the survival of SMEs [54]. Low financial literacy leads to mistakes in financial management [28]. Financial literacy is also needed to face economic challenges [53]. Ouachani et al. [55] reveal that individuals with good financial knowledge are better able to plan investments effectively. Basically, financial literacy is positively correlated with company performance [56], including wealth accumulation [57]. Talking about financial literacy capacity, its role as a consideration in organizational decision making and determining long-term planning is very essential [58; 59]. Companies with good financial literacy have sound financial management. Furthermore, financial literacy has a positive effect on SME sustainability [60]. This leads to our third hypothesis:

Hypothesis 3: *Financial literacy affects SME sustainability.*

According to the RBV approach, a company can achieve competitive advantage if it is supported by valuable and unique resources that are applicable in the work environment [61]. The SME network has a broad impact on prosperity because people have the opportunity to do business even with limited capital. One way to overcome capital shortage is to implement financial inclusion. Chen & Yuan [62] and Dienillah et al. [63] define financial inclusion as equality and availability of opportunities in accessing financial services, including: (1) credits, (2) savings, (3) insurance, (4) payments, and (5) equity. This provides customers with comfort, affordability, suitability, and guarantee of protection. SME sustainability is influenced by financial inclusion [64; 65]. We thus advance our fourth hypothesis:

Hypothesis 4: *Financial inclusion affects SME sustainability.*

One of the main obstacles to SME sustainability is access to capital. Emerging markets with weak financial systems are marked by a poor allocation of financial resources among business organizations [66–68]. Access to capital refers to the availability of financial services, including (1) savings, (2) loans, (3) instalments, and (4) insurance [69]. Companies that are adept at obtaining financial services can receive strong access to capital to meet organizational needs [70]. Overall, SMEs often start from personal financial resources, with family members and relatives providing capital loans in return for a share in the business. As SMEs develop, they need ever greater financial resources to expand, make a profit, and ensure the survival of the company [24].

The use of different methods for creating multicomponent financial literacy has been discussed in recent years. Bajaj & Kaur [71] identify three clusters in the concept of financial literacy: financial behaviour, financial knowledge, and financial attitudes. In the Indian context, these three clusters serve as multidimensional insights that have a significant correlation with each other and combine to form a con-

struct for validating financial literacy based on confirmatory factor analysis (CFA). To promote financial literacy for the younger generation, Folke et al. [72] developed a system called Assessment of Economic and Financial Literacy (ASSET). This measurement has better predictive power and flexibility than other current measurements. With the implementation of ASSET, the ability of the younger generation from across socio-economic statuses and gender will increase in making financial literacy decision. To measure financial literacy, it is necessary to consider multidimensional poverty, including gender, marital status, type of work, and educational background [73]. A fuzzy approach was adopted to raise the level of financial sophistication among employees at the Israeli Central Bureau of Statistics. Rieger [74] studied financial literacy extensively and mapped financial decision measurement instruments, especially stock investments. So far, empirical issues in financial literacy have had little relevance, so they are often overlooked. Financial literacy is crucial for analysing stock investment decisions. Item Response Theory (IRT) and the Graded Response Model (GRM) have been introduced to build sustainable financial literacy. These two scenarios contribute to a complex measure of financial literacy [75]. In turn, IRT and GRM can improve the three dimensions proposed by the Organization for Economic Co-operation and Development (OECD) – financial behaviour, financial attitudes, and financial education – to raise the level of financial literacy of individuals in Brazil.

Some publications document the importance of financial access for SME sustainability. For example, Shepherd et al. [76] find that access to capital is key to building sustainable SME performance. A resilient organization is an organization that has good access to capital. Such organizations are better able to enter the market, expand entrepreneurial activities, increase all-around innovation, and improve risk management skills [77]. Through credit facility policies with low interest rates, SMEs have the opportunity to get stable access to finance and work better [78]. Financial resources balanced with quality circular economy initiatives can generate business independence [79]. This leads to the following hypotheses:

Hypothesis 5: *Access to capital affects SME sustainability.*

Hypothesis 6: *Financial literacy mediated by access to capital affects SME sustainability.*

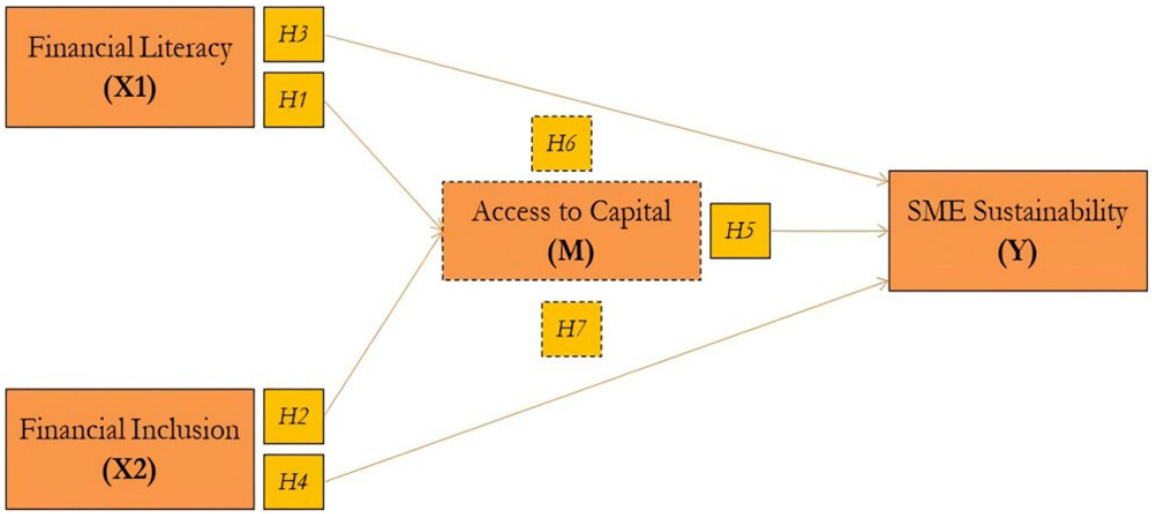
Hypothesis 7: *Financial inclusion mediated by access to capital affects SME sustainability.*

Research Methods

Variables

We observed four variables: 1) financial literacy; 2) financial inclusion; 3) access to capital; and 4) SME sustainability. There are two channels of direct influence: a) financial literacy and financial inclusion on access to capital; and b) financial literacy, financial inclusion and access to capital on SME sustainability. On the other hand, there is an indirect influence of financial literacy and financial inclusion on SME sustainability through access to capital. In the first path, financial literacy and financial inclusion are exogenous variables, while access to capital is an endogenous variable. In the second path, financial literacy, financial inclusion and access to capital are exogenous variables with SME sustainability as the endogenous variable. In the third path, access to capital is a mediating variable that links the exogenous variables (financial literacy and financial inclusion) with the endogenous variable (SME sustainability). Figure 1 shows the exogenous variables (X1 and X2), the endogenous variable (Y), and the mediating variable (M).

Figure 1. Model framework



Source: Compiled by the authors.

Table 1 summarizes the variables and measurements. The four variables have a total of 34 dimensions. Financial literacy includes the following 14 dimensions: 1) knowledge; 2) budget preparation; 3) credit decision behaviour; 4) attitude towards risk; 5) prudence; 6) confidence; 7) experience; 8) effectiveness of financial management; 9) understanding; 10) adaptiveness; 11) financial performance; 12) cash flow; 13) coaching; and 14) skills. Financial inclusion consists of nine dimensions: 1) strategic location; 2) awareness; 3) accessibility; 4) excellence; 5) online services; 6) commitment; 7) priority; 8) account maintenance affordability; and 9) service performance. Access to capital is measured through four dimensions: 1) convenience; 2) flexibility; 3) suitability of capital; and 4) regulations and credit guarantees. Finally, there are seven dimensions of SME sustainability: 1) organizational growth; 2) increased turnover; 3) profit prospects; 4) marketing methods; 5) emotional ties; 6) employee competence; and 7) work environment.

Table 1. Study variables

Variable name	Code and dimensions	Authorship and date
Financial literacy (X1)	X1.1: Have basic accounting knowledge	[80–83]
	X1.2: Preparation of monthly shopping budget	
	X1.3: Be careful when deciding on credit	
	X1.4: Courage to take risks	
	X1.5: Able to reduce financial risks	
	X1.6: Confidence in achieving targets	
	X1.7: Experience in managing finances	
	X1.8: Have effective financial management	
	X1.9: Understand the flow and requirements as a creditor	
	X1.10: Adaptive in using financial services	
	X1.11: Continuous financial performance analysis	
	X1.12: Compile cash flow per day	
	X1.13: Regular employee coaching	
	X1.14: Skills in managing savings, credit and investments	
Financial inclusion (X2)	X2.1: Strategic location of financial institutions	[84; 85]
	X2.2: Awareness of banking product services	
	X2.3: Financial services are easy to access	
	X2.4: Superior financial institution services	
	X2.5: Online-based financial services	
	X2.6: Commitment to providing financial services	
	X2.7: The priority of the bank's financial services is to help SMEs	
	X2.8: Affordable account maintenance fees	
	X2.9: Optimal banking service performance	
Access to capital (M)	M.1: Ease of accessing financial service information	[86–88]
	M.2: Flexibility for SMEs to access credit according to business size	
	M.3: Suitability of capital requirements from the provider institution with the required capacity	
	M.4: Credit regulations and guarantees regarding credit application limits according to procedures	
SME Sustainability (Y)	Y.1: Efforts to accelerate organizational growth	[89–93]
	Y.2: Increase in turnover over time	
	Y.3: Promising business profit prospects	
	Y.4: Marketing methods attract consumers	
	Y.5: Strong emotional bond with customers	
	Y.6: Have competent employees	
	Y.7: Conducive work environment	

Materials and Data Analysis

This study focuses on fashion SMEs in Bali. Data was collected by surveying companies using questionnaire techniques. The interview process was held offline. The informants were categorized as SME owners. The data population was 154,227 units, of which 277 were confirmed as SME leaders. Convenience sampling was designed to take non-probability samples according to appropriate criteria, with a total of 277 samples involved in data collection. Convenience sampling is part of inferential statistics, which determines samples from the closest population. Through convenience sampling, studies can select sample characteristics based on ease of access, involving such practical considerations as saving time and costs. Factors that influence the use of convenience sampling include geographic proximity, availability at a particular time, and willingness to participate. This helps to select respondents from the database (in this case, fashion SMEs) to be contacted and interviewed directly. The informants' perceptions or statements were expressed on a Likert scale with the following four values: 1 = strongly disagree, 2 = disagree, 3 = agree, and 4 = strongly agree. Sampling locations covered eight districts (Badung, Bangli, Buleleng, Gianyar, Jembrana, Karangasem, Klungkung, and Tabanan) and one city (Denpasar). Data tabulation used partial least squares structural equation modeling (PLS-SEM). The PLS-SEM approach was visualized with two software packages: SmartPLS and SPSS. Before testing the hypotheses, the data was first analysed using the following five procedures: (1) CFA, (2) validity, (3) reliability, (4) multicollinearity, and (5) structural model evaluation.

Following Ariani et al. [94], the partial least squares approach (in this case PLS-SEM) was chosen over principal component analysis (PCA) for six reasons: 1) Focuses on observing small samples and optimizing comprehensive statistical output; 2) Can handle many independent variables, even when multicollinearity occurs; 3) More flexible and robust in dealing with different data; 4) Produces models that are analysed in a complex manner; 5) Appropriate for use when prediction is the focus of the study; and 6) Allows data which does not meet the normal distribution to be estimated. Specifically, the main difference between PLS and PCA is that PLS can handle many independent variables, whereas PCA is unsupervised [95; 96]. PLS is applied based on correlation, while PCA does not consider the correlation between the dependent and independent variables. In other words, PLS creates a composite variable by also taking the dependent variable into account and so has a greater correlation with the response than PCA. Furthermore, this study opts for PLS over OLS, because PLS can process models with many factors, while OLS is used to find minimal deviations or errors. The PLS method provides more stable results than OLS in the case of small samples, missing data values, or multicollinearity. PLS is able to handle many independent variables even in the presence of multicollinearity [97]. In general, PLS is a technique that combines the advantages of principal component analysis and multiple regression.

Although PCA is different from PLS, this study involves a component of PCA called the variance inflation factor (VIF). VIF is a modification of the PCA method that is used to overcome multicollinearity problems. VIF also aims to reduce data dimensions that are correlated with each other into data dimensions that are not correlated with certain variables. VIF shows whether there exists a correlation problem between the main component variables. Multicollinearity testing was operated with the Statistical Package for the Social Sciences (SPSS)..

Findings and Discussion

Demographics

Our sample comprised 277 owners or leaders of fashion SMEs (Table 2). The informants had the following age makeup in the order of descending percentage: 36–45 years old (40.1%), 25–35 years old (27.1%), 46–55 years old (21.3%), >55 years old (10.1%), and <25 years (1.4%). In terms of gender, 62.8% of the informants were women and 37.2% were men. The informants' educational background is directly related to the ability of SME managers to operate their business. More than half of the informants (51.3%) had a university diploma or bachelor's degree, while the rest had finished high school (21.7%), a master's programme (13%), junior high school (10.1%), or a doctoral programme (4%). In terms of geography, the majority of SMEs were located in Denpasar (20.6%). The locations of other fashion SMEs included Badung (16.2%), Jembrana (13%), Gianyar (11.9%), Bangli (10.5%), Tabanan (9%), Buleleng (7.2%), Karangasem (6.5%), and Klungkung (5.1%). Denpasar is the predominant location of fashion SMEs, because it is the capital of Bali Province and the centre of Bali's historical civilization with an international reputation.

Table 2. Profile of informants, N = 277

Demographics	Qualification	Frequency	Percent
Age	Less than 25 years old	4	1.4
	25 to 35 years old	75	27.1
	36 to 45 years old	111	40.1
	46 to 55 years old	59	21.3

Demographics	Qualification	Frequency	Percent
Age	Over 55 years old	28	10.1
Gender	Male	103	37.2
	Female	174	62.8
Educational background	Junior high school	28	10.1
	Senior high school	60	21.7
	University or bachelor's degree	142	51.3
	Master's degree	36	13
	Doctoral	11	4
SME location	Badung	45	16.2
	Bangli	29	10.5
	Buleleng	20	7.2
	Gianyar	33	11.9
	Jembrana	36	13
	Karangasem	18	6.5
	Klungkung	14	5.1
	Tabanan	25	9
	Denpasar	57	20.6
Product	Men's and women's clothing	66	23.8
	Traditional costume rental	25	9
	Accessories and jewellery	94	33.9
	Bags	19	6.9
	Shoes	25	9
	Fashion designer services	41	14.8
	Hair and make-up stylist	7	2.5
Operational experience	Less than 3 years	54	19.5
	3 to 6 years	123	44.4
	Over 6 years	100	36.1
Labour force	6 to 19 employees	185	66.8
	20 to 99 employees	92	33.2
Loan type	Working capital credit	206	74.4
	Investment credit	71	25.6
Credit granting institutions	Government bank	87	31.4
	Private bank	51	18.4
	Village unit cooperative (KUD)	139	50.2

Source: Field interview.

Well-known Balinese fashion SMEs work in the following areas: accessories and jewellery (33.9%), men's and women's clothing (23.8%), fashion design services (14.8%), shoes and traditional costume rentals (9%), bags (6.9%), and hair and make-up stylists (2.5%). Generally, fashion SME owners have relatively long business experience: 3–6 years (44.4%), > 6 years (36.1%), and < 3 years (19.5%). Like other regions, Bali has special legislation governing SMEs (Law No. 20 of 2008). Survey data shows that the number of employees at fashion SMEs ranges from 6–19 (66.8%) to 20–99 (33.2%). The most common type of loan is working capital (74.4%), followed by investment credit (25.6%). Half of the credits come from KUD (50.2%). The other two lending institutions are government banks (31.4%) and private banks (18.4%). This signals that the success of fashion SMEs in Bali is inseparable from the role of cooperatives as a trusted credit distribution facility that emphasizes convenience.

Results

Table 3 describes the validity scores of each variable dimension. Wijayanti et al. [98] states that the criteria in the validity test use a loading factor with a minimum limit of 60% (> *0.6*). If the loading factor score is above 0.6, it can be assumed that the reflective construct is formed by valid dimensions. CFA showed that three dimensions had factor loading scores below the limit (< *0.6*): two dimensions of the financial inclusion variable – X2.1 (*OL = 0.583*) and X2.5 (*OL = 0.542*) – and one dimension of the SME sustainability variable – Y.7 (*OL = 0.471*). A total of thirty-one dimensions have loading factor scores above the limit (> *0.6*). The dimension with the highest loading score is M.2 (*OL = 0.909*).

Table 3. CFA of dimensions

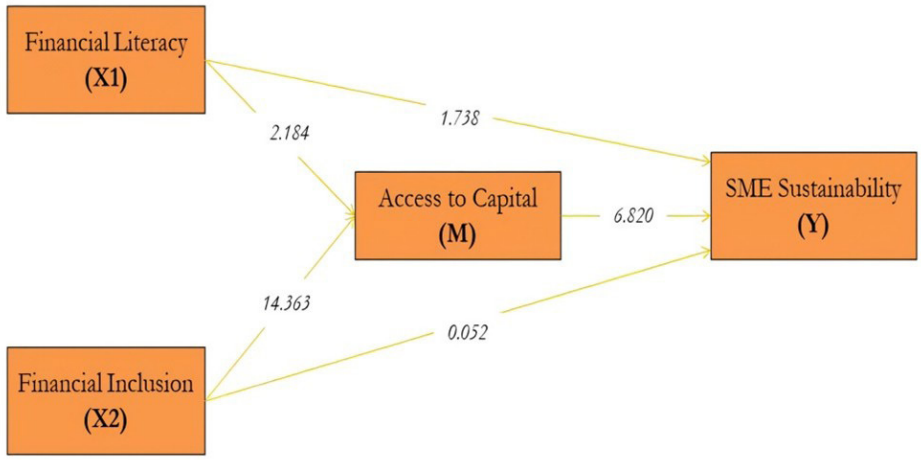
Variables	Dimensions	Outer loading
Financial literacy (X1)	X1.1: Have basic accounting knowledge	.863
	X1.2: Preparation of monthly shopping budget	.793
	X1.3: Be careful when deciding on credit	.877
	X1.4: Courage to take risks	.807
	X1.5: Able to reduce financial risks	.884
	X1.6: Confidence in achieving targets	.767
	X1.7: Experience in managing finances	.844
	X1.8: Have effective financial management	.630
	X1.9: Understand the flow and requirements as a creditor	.888
	X1.10: Adaptive in using financial services	.820
	X1.11: Continuous financial performance analysis	.815
	X1.12: Compile cash flow per day	.806
	X1.13: Regular employee coaching	.762
	X1.14: Skills in managing savings, credit and investments	.859
Financial inclusion (X2)	X2.1: Strategic location of financial institutions	.583
	X2.2: Awareness of banking product services	.668
	X2.3: Financial services are easy to access	.654
	X2.4: Superior financial institution services	.609
	X2.5: Online-based financial services	.542
	X2.6: Commitment to providing financial services	.634
	X2.7: The priority of the bank's financial services is to help SMEs	.779
	X2.8: Affordable account maintenance fees	.633
	X2.9: Optimal banking service performance	.742
Access to capital (M)	M.1: Ease of accessing financial service information	.904
	M.2: Flexibility for SMEs to access credit according to business size	.909
	M.3: Suitability of capital requirements from the provider institution with the required capacity	.905
	M.4: Credit regulations and guarantees regarding credit application limits according to procedures	.865

Variables	Dimensions	Outer loading
SME Sustainability (Y)	Y.1: Efforts to accelerate organizational growth	.770
	Y.2: Increase in turnover over time	.819
	Y.3: Promising business profit prospects	.795
	Y.4: Marketing methods attract consumers	.660
	Y.5: Strong emotional bond with customers	.685
	Y.6: Have competent employees	.630
	Y.7: Conducive work environment	.471

Source: Data computing via SmartPLS.

Next, we calculate the standardized factor loading (SFL), which describes the strength of exogenous variables in forming the model. In this case, the model analyses access to capital and SME sustainability (Figure 2). Ideally, the SFL coefficient should be above 70% (> *0.7*). Of the five impacts, four give strong results: financial literacy on access to capital (*SFL = 2.184*), financial inclusion on access to capital (*SFL = 14.363*), financial literacy on SME sustainability (*SFL = 1.738*), and access to capital on SME sustainability (*SFL = 6.820*). At the same time, the impact of financial inclusion on SME sustainability has an SFL coefficient below the limit (*SFL = 0.052*).

Figure 2. CFA of variables



Source: Data computing via SmartPLS.

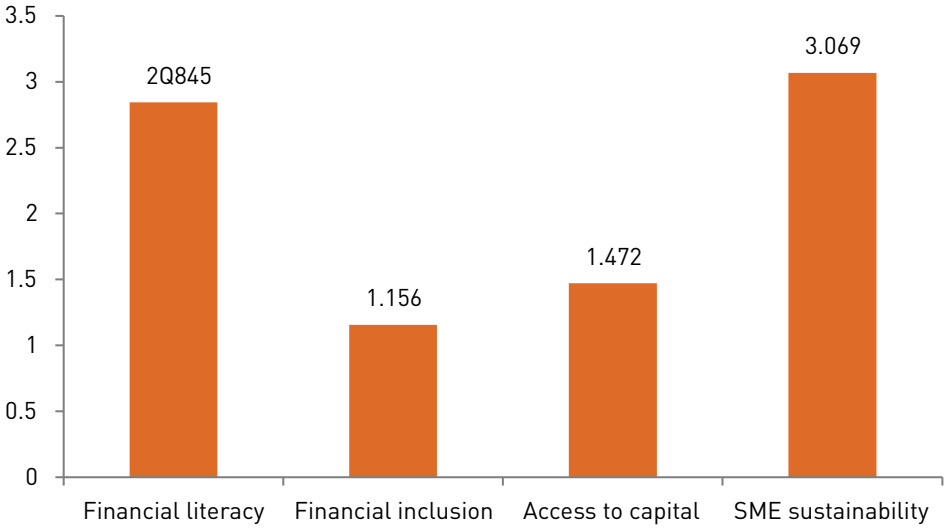
In PLS, three methods are used for reliability testing: 1) Cronbach's Alpha/CA; 2) Composite Reliability/CR; and 3) Average Variance Extracted/AVE. CA measures the lower limit of the reliability score, CR calculates the actual value of reliability, while AVE checks whether the model has good reliability [99]. To prove the accuracy of the model, both CA and CR must be above 70% (> *0.7*). In criteria-based reliability, the AVE score must be greater than 50% (> *0.5*). Low AVE indicates that the model needs improvement. Table 4 displays reliability testing results using the three methods. All three tests (CA, CR, and AVE) show that all variables in the model are reliable. The largest CA score was found for financial literacy (*CA = 0.962*), and the lowest for SME sustainability (*CA = 0.875*). For the CR method, financial literacy had the highest score (*CR = 0.967*), while financial inclusion had the lowest (*CR = 0.877*). Finally, for the AVE method, access to capital received the highest score (*AVE = 0.803*), and financial literacy the lowest (*AVE = 0.690*).

Table 4. Reliability test

Variables	Cronbach's alpha	Composite reliability	Average variance extracted
Financial literacy	.962	.967	.690
Financial inclusion	.729	.877	.781
Access to capital	.918	.942	.803
SME sustainability	.875	.922	.799

Source: Data computing via SmartPLS.

Figure 3. Statistical collinearity test



Source: Data computing via SPSS.

We use VIF to test for multicollinearity in this study. If this problem is detected, one would have to develop an alternative to overcome multicollinearity in PLS-SEM. VIF is a measure of how correlated a predictor variable is with other variables in the designed model. The value of VIF indicates the degree of multicollinearity as follows: (1) VIF ≥ 10 indicates serious multicollinearity that requires further investigation, (2) VIF ≥ 5 indicates potentially problematic multicollinearity, (3) 1 < VIF < 5 represents moderate correlation and generally acceptable results, and (4) VIF = 1 indicates there is no correlation between the predictor variable and other variables. From Figure 3, we see that the VIF scores of financial literacy (2.845), financial inclusion (1.156), access to capital (1.472), and SME sustainability (3.069) are all below the threshold (1 < VIF < 5). Thus, the constructed variables may be considered accurate predictors of the model.

We evaluate the model structure by using the R-Square (R^2) and Adjusted R-Square coefficients (Table 5). According to Christian et al. [100], these coefficients show whether a model is weak or strong as follows: a model is strong if $R^2 > 0.67$, moderate if $0.66 \geq R^2 \geq 0.33$, and weak if $0.32 \geq R^2 \geq 0.19$. In our case, we find that the models for the impact of financial literacy and financial inclusion on access to capital ($R^2 = 0.803$) and for the impact of financial literacy, financial inclusion and access to capital on SME sustainability ($R^2 = 0.728$) are both strong. The Adjusted R^2 coefficient shows that both models have high determination: *Adjusted* $R^2 = 0.800$ for the impact of financial literacy and financial inclusion on access to capital and *Adjusted* $R^2 = 0.721$ for the impact of financial literacy, financial inclusion, and access to capital on SME sustainability. Thus, the R^2 scores show that the models for access to capital and SME sustainability are both strong, while the Adjusted R^2 value indicates that the results are influence by 20% other components in the access to capital model and 27.9% in the SME sustainability model.

Table 5. Evaluation of the structural model

Variables	R-square	Adjusted R-square
Access to capital	.803	.800
SME sustainability	.728	.721

Source: Data computing via SmartPLS.

Next, we run empirical hypothesis testing to check whether the proposed model is acceptable or not. Using two PLS-SEMs, we find that six hypotheses are acceptable, while two are not. There is a significant relationship if the T-statistic is above 1.96 *(> 1.96)* with a probability value below 5% *(<0.05)*. This confirms the first hypothesis that financial literacy has a significant effect on access to capital (*T-statistic = 2.184 > 1.96*; *Prob. = 0.029 < 0.05*), as well as the second hypothesis that financial inclusion has a significant effect on access to capital (*T-statistic = 14.363 > 1.96*; *Prob. = 0.000 < 0.01*). However, the third hypothesis is rejected: financial literacy does not have a significant effect on SME sustainability (*T-statistic = 1.738 < 1.96*; *Prob. = 0.083 > 0.05*). So is the fourth hypothesis: financial inclusion has an insignificant effect on SME sustainability (*T-statistic = 14.363 > 1.96*; *Prob. = 0.000 < 0.01*). The remaining three hypotheses are confirmed: for the fifth hypothesis, access to capital has a significant effect on SME sustainability (*T-statistic = 6.820 > 1.96*; *Prob. = 0.000 < 0.01*). For the sixth hypothesis, financial literacy has a significant effect on SME sustainability through access to capital (*T-statistic = 2.205 > 1.96*; *Prob. = 0.028 < 0.05*). For the seventh hypothesis, financial inclusion has a significant effect on SME sustainability through access to capital (*T-statistic = 5.714 > 1.96*; *Prob. = 0.000 < 0.01*).

Table 6. Summary of hypothesis testing

Hypothesis and linkages	Original sample	Sample mean	Standard deviation	T-statistic	P-value
H1. Financial literacy → Access to capital	.140	.151	.064	2.184	.029*
H2. Financial inclusion → Access to capital	.801	.791	.056	14.363	.000**
H3. Financial literacy → SME sustainability	.158	.164	.091	1.738	.083
H4. Financial inclusion → SME sustainability	.005	-.009	.089	.052	.959
H5. Access to capital → SME sustainability	.738	.747	.108	6.820	.000**
H6. Financial literacy → Access to capital → SME sustainability	.103	.111	.047	2.205	.028*
H7. Financial inclusion → Access to capital → SME sustainability	.591	.592	.103	5.714	.000**

Note: **p < 1% and *p < 5%.

Source: Data computing via SmartPLS.

As Table 6 shows, access to capital carries out its function as a mediating variable. Financial literacy and financial inclusion cannot ensure SME sustainability without access to capital. By including access to capital in the study model, we show that both financial literacy and financial inclusion can influence the sustainability of fashion SMEs.

The lack of influence of financial literacy on sustainability is due to the high level of finance management skills among fashion SME leaders. Meanwhile, the impact of financial inclusion on sustainability is not significant due to accessibility, such as minimal financial institution unit and weak online financial service systems. In the RBV landscape, knowledge is seen as a tool for improving organizational performance [14; 19]. KBV also emphasizes the importance of furthering the integration of individual abilities and company knowledge for developing services and products [17]. As shown by Eniola and Entebang [101], Kotzé & Smit [102], and Ye & Kulathunga [24], companies need to implement good communication and partnerships to gain access to capital.

Quantitatively, our results show that an improvement in financial literacy and financial inclusion increases access to capital. Support for adequate access to capital promotes the sustainability of fashion SMEs. Additionally, the positive synergy between financial literacy and financial inclusion in encouraging fashion sustainability through the mediation of access to capital shows that capital access programmes offered by financial institutions are well organized. Their financial services are useful to SMEs, increasing their income. Mutamimah & Indriastuti [103], Bongomin et al. [104], Purwanti & Fatmawati [105], Tubastuvi & Purwidianti [106], and Yakob & Hafizuddin-Syah [107] examined the relationship between access to capital, financial inclusion, financial literacy and SME performance, leading to five mixed findings: 1) financial inclusion moderated by financial literacy can improve business performance; 2) financial literacy moderates the relationship between access to capital and SME growth; 3) financial inclusion and literacy can improve SME performance; 4) the mediating effect of financial inclusion in the relationship between financial literacy and SME performance is positive; and 5) financial literacy, as measured by financial administration skills, has a positive influence on SME performance.

Conclusion

This study investigated the impact of financial literacy and financial inclusion on access to capital and sustainability of fashion SMEs in Bali. By testing hypotheses with PLS-SEM, we showed that financial literacy and financial inclusion significantly influence access to capital. Furthermore, neither financial literacy nor financial inclusion influences SME sustainability in a significant way. Only access to capital has a direct and significant effect on SME sustainability. Only financial literacy and financial inclusion mediated by access to capital can significantly influence SME sustainability.

Financial literacy and financial inclusion play a role in encouraging the sustainability of fashion SMEs when supported by access to capital. As the statistical results show, access to capital plays a positive role in increasing the sustainability of fashion SMEs and moderates the impact of financial literacy and financial inclusion on the sustainability of fashion SMEs. This suggests that access to capital not

only plays a role in the distribution of working capital loans but is also experiencing a shift in the form of investment credit services. Loans such as investment credits have several benefits for SMEs: 1) increasing income and expanding markets; 2) encouraging efficiency and productivity; 3) maintaining market position; 4) obtaining financial support; (5) improving service quality and products; and (6) strengthening competitiveness.

This study has several practical implications. SME leaders should develop employees through information technology training in the financial sector. Transformations in the field of financial service information can accelerate the transfer of knowledge about inclusion and financial literacy. Good financial literacy and inclusion help financial institutions to gain access to capital. The weakness of this study is that it focuses on one type of SME. For further research, one can consider a larger sample size that would permit comparisons between SMEs working in different areas.

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