Vol. 16 | № 1 | 2022 cfjournal.hse.ru ISSN 2073-0438

JOURNAL OF CORPORATE FINANCE RESEARCH

New Research | Corporate Financial Analytics | Applied Financial Analytics | Methods | Reviews | Discussions

Journal of Corporate Finance Research

Vol. 16 | № 1 | 2022
e-journal

www.cfjournal.hse.ru
ISSN 2073-0438

Contacts:
Higher School
of Economics (HSE),
11 Pokrovsky Boulevard, Building S
Tel.: +7 (495) 621 9192*27188
E-mail: cf@hse.ru

Journal of Corporate Finance Research (JCFR) was established in 2007. It is founded by the National Research University Higher School of Economics (NRU HSE) and **Irina Ivashkovskaya** (chief editor). The journal is included in Web of Science Russian Science Citation Index (RSCI).

Journal of Corporate Finance Research aims to publish high quality and well-written papers that develop theoretical concepts, empirical tests and research by case studies in corporate finance.

The scope of topics that are most interesting to JCFR includes but is not limited to: corporate financial architecture, payout policies, corporate restructuring, mergers and takeovers, corporate governance, international financial management, behavioral finance, implications of asset pricing and microstructure analysis for corporate finance, private equity, venture capital, corporate risk-management, real options, applications of corporate finance concepts to family-owned business, financial intermediation and financial institutions.

JCFR targets scholars from both academia and business community all over the world.

Frequency: 4 times per year

The Journal of Corporate Finance Research is committed to upholding the standards of publication ethics and takes all possible measures against any publication malpractices. Editors of the journal reserve the right to reject the work from publication in case of revealing any such malpractices.

Guidelines for authors:
https://cfjournal.hse.ru/en/for%20authors.html.

Editorial Staff

Editorial board

Contents

Journal of Corporate Finance Research
Vol. 16 | № 1 | 2022
www.cfjournal.hse.ru

New Research

Reviews

DOI: https://doi.org/10.17323/j.jcfr.2073-0438.16.1.2022.5-13
JEL classification: G32; O16

Empirical Analysis of Motives for Intra-Group Lending in Russian Business Groups

Yana Korotkova
Engineer, Projects Department, Lomonosov Moscow State University, Faculty of Economics, Moscow, Russia, yikorotkova@econ.msu.ru, ORCID

Abstract

This study examines the factors behind the companies' financial roles on the internal capital markets of Russian business groups. The main goal is to determine the driving motives for intra-group lending in Russia. To find relevant answers, we use logit- and ordered logit-models based on 2018–2020 panel data for 239 Russian joint stock companies representing 21 business groups. Considering the findings of prior studies on debt financing in business groups, we analyze the influence of company size and age, asset tangibility and profitability, leverage, liquidity, sales growth, and the cash-flow rights of controlling shareholders on the probability of a company being a provider (receiver) of intra-group loans. The novelty of our findings is ensured by the use of data from the State Information Resource of Financial Accounts that were made publicly available in 2020, enabling us to significantly expand the set of companies under examination. The results of this empirical analysis reveal that internal capital markets of Russian business groups serve as a tool for fund reallocation from older and larger, but less capital-intensive and leveraged companies to smaller, more capital-intensive and leveraged members of the group. The findings demonstrate that the financing advantage motive for intra-group lending is currently predominant in the leading Russian business groups. Thus, Russian business groups use their internal capital markets as an alternative source of funds that alleviates the financing constraints of group members. In the context of continuing anti-Russian sanctions, the limited depth of the Russian financial market and a lack of "long" money in the economy, the research results can be useful for financial managers and policymakers seeking ways to enhance the financial security of group-affiliated companies.

Keywords: internal capital market, business group, intra-group loans, financing advantage, tunneling, financing constraints

For citation: Korotkova, Y. Empirical Analysis of Motives for Intra-Group Lending in Russian Business Groups. *Journal of Corporate Finance Research.* 2022;16(1): 5-13: https://doi.org/10.17323/j.jcfr.2073-0438.16.1.2022.5-13

Introduction

Motivated by the high prevalence of business groups in developing and even developed countries, as well as by the active redistribution of capital between group-affiliated companies, research on internal capital markets of business groups in different countries and regions reveals controversial evidence on the effects of intra-group financing transactions. On the one hand, aimed at winner-picking [1] and creating co-insurance effects [2], the functioning of internal capital markets is beneficial to various types of business group stakeholders; on the other hand, internal capital markets can be engaged in the so-called 'corporate socialism' [3] or be misused by controlling shareholders to extract private benefits at the cost of other investors.

To ascertain that the bright side of internal capital markets in business groups outweighs the dark side, their inner workings have been examined through various lenses. One strand of literature focuses on the investment policies of business groups and assesses the efficiency of internal capital markets by analyzing the sensitivity of investment to cash flow in group-affiliated companies [4–7]. Another strand of literature investigates the interrelation between dividend policy decisions and reallocation of financial resources within business groups [8–10]. Equity offerings in business groups are yet another subject of growing attention [11; 12]. Finally, debt allocation across group member companies has also been examined on data from various countries [13–15]. When detectable through publicly available sources, intra-group loans are an important empirical basis for research on the functioning of internal capital markets as they do not require fair value estimations, unlike other transfers between group member companies [15, p. 2].

Russian business groups hold the leading positions in the national economy. It is widely accepted that they invariably play a predominant role in the country's economic development [16, p. 30]. Recent estimates of the volumes of financing provided to and raised from related parties by Russian public non-financial companies with shares listed in Moscow Exchange's First Tier quotation list demonstrate that internal capital markets of the leading Russian business groups are not just functioning, but are becoming more active over time [17]. Yet the exact nature and motives of these activities have remained largely unexamined up until now. We seek to fill this gap by investigating the factors behind the allocation of financial roles (providers and receivers of intra-group loans) to companies on the internal capital markets of Russian business groups.

In this study we benefit from the fact that the data from the State Information Resource of Financial Accounts maintained by the Federal Tax Service of Russia (hereinafter referred to as the FTS resource) have become publicly available in 2020. Owing to the disclosure of comparative information on the preceding periods in financial accounts, the FTS resource allowed us to collect empirical data for the years 2018–2020 for a set of 239 Russian joint stock companies. Meanwhile, the existing research on the determinants of financial roles of Russian group-affiliated companies was based on a rather limited sample of 47 companies [18].

In the context of the inability of the Russian financial market depth to fully meet the needs of the national economy [19, p. 19], the limited availability of "long" money that leads to a high cost of investment credit [20, p. 102] and ongoing anti-Russian sanctions, the research results can contribute to a deeper understanding of business groups' potential to alleviate financing constraints of affiliated companies through the groups' internal capital markets.

The remainder of the paper is organized as follows. The literature review explains the reasons to distinguish between financing advantage and tunneling motives for intra-group financing and summarizes the findings of prior research on intra-group loans. The next section presents the hypotheses of this study. The empirical part of the article first describes the methodology and data used, then the construction of the sample, and presents the results of our estimations. The final section is a summary of the key findings on the motives for intra-group loans within Russian business groups.

State of knowledge

A proper functioning of internal capital markets of business groups can help alleviate the financing constraints of group-affiliated companies [21; 22] and facilitate their investment [22–24], decrease the companies' precautionary demand for money by smoothing out liquidity fluctuations [25; 26], partly replace costly external financing with a cheaper and more flexible intra-group funding [13]. A condition required to keep internal capital markets of business groups on this bright side is related to the motivation of the groups' controlling shareholders to reallocate group capital resources. Relevant literature describes three basic motives for intra-group financial transactions, which are (1) financing advantage, (2) tunneling, and (3) propping [27, p. 766]. Out of these motives, it's the financing advantage motive that has the above-mentioned 'bright' implications for business groups. This motive implies that capital flows between group-affiliated companies are related to the differences in the degree of financing constraints that the companies face. Companies enjoying financing surpluses are prone to enter the group internal capital market as providers of funds to related parties, while companies that face financing deficits are to become the receivers of intra-group funds.

On the dark side of business groups, it is the tunneling motive for the use of internal capital markets. If we differentiate between group-affiliated companies by the cash-flow rights of their controlling shareholders (i.e., the fraction of company dividends attributable to the shareholder), tunneling implies that companies with low cash-flow rights of the controlling shareholder will act as financing donors to companies with high cash-flow rights of the controlling shareholder. Prior evidence shows that in the course of tunneling practices donor companies suffer from drops in asset profitability and share prices [28; 29], a raise in leverage aimed at boosting their donor potential [30] and, consequently, an increased risk of financial distress [15].

Prior research on intra-group lending aimed to identify its predominant motives by examining the origination and settlement of intra-group loans.

For Chinese business groups, analysis of intra-group loans on a wide sample of listed companies revealed large-scale tunneling of funds by controlling shareholders [15]. It was demonstrated that other receivables (including intra-group loans) of companies scaled by their total assets were directly traceable to controlling shareholders of these companies and were negatively related to company size and profitability, and positively related to company leverage.

For Belgian private business groups, analysis of internal debt concentration of group member companies provided evidence in support of the financing advantage motive for debt financing. The more difficulty subsidiaries faced in attracting external financing (as younger companies and/or companies with lower profitability of assets), the more intra-group loans they received [14].

For Chilean business groups, the key factors that determine the direction of intra-group credit flows proved to be leverage, profitability, and investment in property, plant, and equipment of companies. In line with the financing advantage motive, receivers were typically more capital-intensive, profitable, and leveraged [13].

For Russian business groups, a study of intra-group loan payable and receivable balances of 47 joint stock non-financial companies provided evidence that the probability of a company providing intra-group loans is positively associated with its size and negatively associated with its leverage and capital intensity, as the financing advantage motive prescribes [18]. Although that paper tried to address the gap in the understanding of intra-group financing in Russian business groups, the scope of that work, with regard to the number of companies and business groups, as well as potential determinants covered, it has left significant space for further research and led us to conduct this study.

Methodology

With regard to the financial role on the internal capital market of a business group, group-affiliated companies can be divided into providers of intra-group loans, receivers of intra-group loans, and companies with a neutral credit status. We follow the approach suggested by D. Buchuk et al., and classify a company as a provider (receiver) of intra-group loans if the company's net intra-group loans (the difference between loans receivable from related parties and loans payable to related parties) is no less (no more) than 5% (–5%) of the company's book assets [13, p. 198]. The remaining group members are characterized as companies with a neutral credit status.

We use a logit model to estimate the effect of ownership and financial variables on the probability of companies being providers (receivers) of intra-group loans. The dependent variables used for this analysis are dummy variables $RECEIVER_{it}$ ($PROVIDER_{it}$), whose value is 1 if company i is a receiver (provider) of intra-group loans at the end of year t, and 0 otherwise.

Table 1 details the approach used to calculate explanatory variables used in the empirical study.

Table 1. Description of the explanatory variables used in the study

Factor	Variable	Variable description
Position of a company in the business group	CFR – cash flow rights of the controlling shareholder	Proportional claim of the group's controlling shareholder to company dividends at the year-end [13, p. 191]
Company size	SIZE – company size	Natural logarithm of book assets at the year-end
Company age	AGE – company age	Number of years since the company's state registration
Capital intensity	TANG – assets tangibility	Ratio of property, plant, and equipment to book assets at the year-end
Profitability	ROA – return on assets	Ratio of company's net income in the year to the average of book assets during the year
Growth opportunities	SG – sales growth	Percent change in sales from prior year
Leverage	LEV – leverage	Debt-to-assets ratio (book values at the year-end)
Liquidity	CLR – current ratio	Ratio of current assets to current liabilities at the year-end
Financial assets	FA – financial assets (share of total assets)	Ratio of financial assets to book assets at the year-end
State control	STATE – state control	Dummy: 1 if the company is state-controlled and 0 otherwise

Source: Prepared by the author.

Equations (1) and (2) stand for the models to be estimated:

$$RECEIVER_{it} = F\begin{pmatrix} a\bullet CFR_{i,t-1} + b\bullet CFR_{i,t-1}\bullet STATE_{i,t-1} + \\ +c\bullet SIZE_{i,t-1} + d\bullet AGE_{i,t-1} + e\bullet TANG_{i,t-1} + \\ +f\bullet ROA_{i,t-1} + h\bullet SG_{i,t-1} + j\bullet LEV_{i,t-1} + \\ +k\bullet CLR_{i,t-1} + l\bullet FA_{i,t-1} + \varepsilon_{it} \end{pmatrix}, \quad (1)$$

$$PROVIDER_{it} = F\begin{pmatrix} a\bullet CFR_{i,t-1} + b\bullet CFR_{i,t-1}\bullet STATE_{i,t-1} + \\ +c\bullet SIZE_{i,t-1} + d\bullet AGE_{i,t-1} + e\bullet TANG_{i,t-1} + \\ +f\bullet ROA_{i,t-1} + h\bullet SG_{i,t-1} + j\bullet LEV_{i,t-1} + \\ +k\bullet CLR_{i,t-1} + l\bullet FA_{i,t-1} + \varepsilon_{it} \end{pmatrix}, \quad (2)$$

where F is the standard logistic function.

Considering there is a significant set of companies with a neutral financial role on the internal capital markets of their business groups, we also estimate an ordered logit model. The dependent variable in this model is $FINROLE_{it}$, and it assumes the value of 0 if company i at the end of year t is a receiver of intra-group loans, the value of 1 if its financial role in the internal capital market is neutral, and the value of 2 if it is a provider of intra-group loans.

The equation (3) stands for the ordered logit model:

$$FINROLE_{it} = F\begin{pmatrix} a\bullet CFR_{i,t-1} + b\bullet CFR_{i,t-1}\bullet STATE_{i,t-1} + \\ c\bullet SIZE_{i,t-1} + d\bullet AGE_{i,t-1} + e\bullet TANG_{i,t-1} + \\ +f\bullet ROA_{i,t-1} + h\bullet SG_{i,t-1} + j\bullet LEV_{i,t-1} + \\ +k\bullet CLR_{i,t-1} + l\bullet FA_{i,t-1} + \varepsilon_{it} \end{pmatrix}. \quad (3)$$

We use lagged regressor values in the models to avoid possible endogeneity issues, as a company's financial role in the internal capital market can simultaneously influence the company financial characteristics. To address potential heteroskedasticity, we use robust QML standard errors.

Development of research hypotheses

The hypotheses of this study are developed in line with the assumptions of the financing advantage motive for the use of internal capital markets of business groups.

Hypothesis 1. There is no significant correlation between the probability of being a receiver (provider) of intra-group loans and the cash-flow rights of the controlling shareholder.

Motivation. The financing advantage motive for intra-group transactions assumes that the direction of capital flows in the internal capital market of a business group is determined by the differences in financing deficits and surpluses of the group companies. At the same time, the differences in the cash-flow rights of the controlling shareholder of the group companies determine the direction of intra-group capital flows in case of tunneling.

Hypothesis 2. There is a negative (positive) correlation between the probability of being a receiver (provider) of intra-group loans and company size.

Hypothesis 3. There is a negative (positive) correlation between the probability of being a receiver (provider) of intra-group loans and company age.

Motivation. It is generally accepted that a company's access to financing expands over the company life cycle. Thus, smaller and younger (larger and older) firms are more likely to face financing deficit (surplus) and use the internal capital market of their business groups to receive funds from (provide funds to) related parties.

Hypothesis 4. There is a positive (negative) correlation between the probability of being a receiver (provider) of intra-group loans and the tangibility of company assets.

Motivation. Tangible assets can be pledged as collateral, thus, all other things being equal, companies with higher (lower) asset tangibility have easier (more difficult) access to external financing, including intra-group funds.

Hypothesis 5. There is a negative (positive) correlation between the probability of being a receiver (provider) of intra-group loans and the profitability of company assets.

Motivation. Less (more) profitable firms, all other things being equal, have smaller (larger) internal fundings and are more likely to face financing deficit (surplus), encouraging them to receive (provide) intra-group funds.

Hypothesis 6. There is a positive (negative) correlation between the probability of being a receiver (provider) of intra-group loans and company growth opportunities.

Motivation. The greater a company's growth opportunities, the more funds it needs to finance them. Thus, ceteris paribus, companies with more (fewer) growth opportunities are more (less) likely to face financing deficit that can be covered by intra-group funds.

Hypothesis 7. There is a positive (negative) correlation between the probability of being a receiver (provider) of intra-group loans and company leverage.

Motivation. According to the pecking order theory of capital structure, high leverage means that internal sources of financing are not sufficient to meet a company's funding needs, hence, the company is more likely to be financially constrained and seek intra-group loans.

Hypothesis 8. There is a negative (positive) correlation between the probability of being a receiver (provider) of intra-group loans and a company's liquidity level.

Motivation. The higher a company's level of liquidity, the less financially constrained it is, ceteris paribus, hence, the lower the probability a company becomes a receiver of intra-group loans.

Hypothesis 9. There is a negative (positive) correlation between the probability of being a receiver (provider) of intra-group loans and the share of financial assets in the total company assets.

Motivation. In non-financial companies, a high fraction of company resources available for financial investments

should mean that, all other things being equal, the company is less financially constrained, hence, it has a lower probability of becoming a receiver of intra-group loans.

Data

Since the beginning of 2020, the financial data from the FTS resource have become publicly available. It allowed us to use the data on amounts of loans receivable from related parties and loans payable to them at the end of each year from 2018 to 2020. We manually collected these data from explanatory notes on related parties included in the companies' annual financial reports under RAS. The data for the years 2016–2020 used to calculate the explanatory variables were extracted from the SPARK-Interfax database. Moreover, we used the data provided by Russian authorized corporate information disclosure agencies (lists of affiliates and issuer's quarterly reports of the companies in question) and analyzed the information available in the SPARK-Interfax database on the position of companies in ownership chains.

The set of companies with ordinary shares included in the First-Level Quotation List of Moscow Exchange as of October 1, 2021 was used as a starting point for the sample construction. From the initial set of 41 public companies, we consecutively excluded:

- 6 finance companies (PJSC VTB BANK, PJSC 'Bank 'Saint-Petersburg', Credit Bank of Moscow PJSC, Sberbank of Russia PJSC, PJSC Moscow Exchange MICEX-RTS, SFI PJSC) and 2 construction companies (LSR Group PJSC, PJSC PIK-specialized homebuilder);
- En+ Group MKPAO and United Company RUSAL MKPAO due to their redomiciliation to Russia after 2018;
- 5 companies (Detsky Mir PJSC, PJSC 'M.video', PJSC Enel Russia, Unipro PJSC, PJSC 'Magnit') whose business groups do not include any other joint stock companies (based on SPARK-Interfax 'Ownership Analysis' data service) that disclosed information on related party transactions for the years 2018–2020 in explanatory notes to financial reports.

The final sample is thus comprised of 26 public companies with ordinary shares included in the First-Level Quotation List of Moscow Exchange and 213 joint stock companies affiliated with them. The companies represent 21 Russian business groups. The sampling design and the three-year period in question (years 2018–2020) allowed to obtain a balanced panel data set of 717 firm-year observations. The years from 2017 to 2020 were used to calculate the explanatory variables for the study.

Results and discussion

Based on the ratio of net intra-group loans to book assets of a company at the year-end, we labeled each firm-year observation as a provider or a receiver of intra-group loans, or a company with a neutral credit status. 210 firm-year observations (29%) were classified as receivers, and 176 firm-year observations (25%) were classified as providers of intra-group loans. It is worth noting that the financial role of the companies on the internal capital markets of their business groups tends to be persistent over time, as it did not change for 169 companies out of 239 (71%) within the observation period.

Table 2 reports summary statistics for the explanatory variables. There are some significant outliers associated with the current ratio (the maximum value observed in the sample is 3183.7 caused by a company's refusal to use short-term loans) and with the sales growth (the maximum value observed is 396.6 caused by a low base effect). To mitigate the effects of outliers, we winsorized these variables at the top 1% of their distribution.

Table 2. Summary statistics for explanatory variables

Variable	Mean	Median	Standard deviation	Minimum	Maximum
CFR	0.857	0.957	0.183	0.213	1.000
ROA	0.040	0.028	0.181	–1.265	1.048
SIZE	15.960	15.821	2.672	6.632	23.491
TANG	0.330	0.261	0.297	0.000	0.989
CLR	11.663	1.336	121.750	0.000	3183.700
CLR (wins.)	6.756	1.336	21.736	0.000	175.410
LEV	0.232	0.069	0.452	0.000	5.148
AGE	19.343	20.500	6.665	2.000	29.500
SG	2.093	0.047	25.868	–1.000	396.640
SG (wins.)	0.312	0.047	1.489	–1.000	11.127
FA	0.207	0.026	0.299	0.000	0.9998

Notes: (Wins.) stands for a variable winsorized at the top 1% of its distribution to mitigate the effect of outliers.
Source: Author's calculations.

Table 3. Median values for explanatory variables by subsample based on companies' financial roles in internal capital markets of business groups

Subsample	Receivers	Companies with a neutral financial role	Providers
Observations, firm-year	210	331	176
Controlling shareholder's cash flow rights (CFR), %	95.30	96.10	94.90
Company size (SIZE)	16.28	15.43	15.93
Company age (AGE), years	19.50	18.00	24.00
Tangibility (TANG), %	38.60	25.40	17.70
ROA, %	1.30	2.15	6.32
Sales growth (SG), %	5.05	4.50	4.62
Leverage (LEV), %	36.22	0.00	0.00
Current ratio (CLR)	0.78	1.48	2.52
Financial assets as a share of total assets (FA), %	0.70	0.20	33.50

Source: Author's calculations.

We start our analysis by comparing the subsamples based on companies' financial roles in internal capital markets of business groups. Table 3 reports the median values of explanatory variables for providers, receivers, and companies with a neutral financial role in the internal capital market of their business group.

Comparative analysis of the subsamples shows that the median value of the controlling shareholder's cash-flow rights for receivers is slightly (0.4 p.p.) higher than for providers of intra-group loans, not giving us a reason to expect tunneling via internal capital markets. The median value of receivers' asset profitability is lower than that of other companies. Lower profitability of receivers may indicate that these companies have relatively low retained earnings, and may seem less attractive to outside investors compared with providers. The higher median value of asset tangibility of receivers indicate they are more capital-intensive than providers of intra-group loans. Receivers are also characterized by a higher median age but a lower median rate of sales growth that can indicate the predominance of growth firms among receivers and mature firms among providers of intra-group loans. Taken together, these median characteristics may indicate that receivers (providers) are prone to a financing deficit (surplus), which encourages these companies to engage in intra-group lending in accordance with the financing advantage motive.

To avoid possible multicollinearity issues in the models, we verified that the absolute values of pair correlation coefficients for the explanatory variables do not exceed 0,5 (Table 4 contains the correlation matrix). As there is no close relationship between the regressors, we consider multicollinearity risks low.

Table 4. Correlation matrix for the explanatory variables

	CFR	ROA	SIZE	TANG	CLR	LEV	AGE	SG	FA
CFR	1.0	0.0581	0.1619	–0.1383	0.0623	0.0573	–0.0236	0.0554	0.1296
ROA		1.0	0.1985	–0.0741	0.0227	–0.3899	0.1937	–0.0876	0.0221
SIZE			1.0	0.1408	–0.1027	–0.0136	0.0150	0.0701	0.2991
TANG				1.0	–0.1781	–0.0051	–0.0017	–0.0570	–0.4956
CLR					1.0	–0.1308	–0.0093	0.0870	0.0660
LEV						1.0	–0.1203	0.0644	0.0348
AGE							1.0	–0.1364	–0.0545
SG								1.0	0.1003
FA									1.0

Source: Author's calculations.

Table 5 presents logit (1, 1a, 2, 2a) and ordered logit (3, 3a) regressions.

Estimation results confirm that asset tangibility and company leverage have a positive impact on the company's probability of being a receiver of intra-group loans (Hypotheses 4 and 7). Furthermore, the results confirm the negative impact of company size on its probability of being a receiver in the internal capital market (Hypothesis 2). Hence, on average, the receivers of intra-group loans are smaller, but more capital-intensive and leveraged companies that, based on these characteristics, are more likely to be financially constrained. Providers of intra-group loans are, on average, larger, older, and less capital-intensive firms with relatively low leverage. We can interpret the positive relationship between the share of financial assets in the total assets of a company and its probability of being a provider of intra-group finds (Hypothesis 9 is confirmed by the estimation results) as evidence that Russian group-affiliated companies use intra-group loans as part of an extensive integrative growth strategy [31, p. 23].

In sum, estimation results provide evidence in support of a financing advantage motive for the use of internal capital markets in Russian business groups.

It is worth noting that only in case of state-controlled business groups there is a negative relationship between the cash-flow rights of the controlling entity and the company's probability of being a provider of intra-group funds. Though this single finding corresponds to the tunneling motive for intra-group lending, earlier we showed that providers of intra-group loans are on average more profitable than receivers. Hence, there is no convincing evidence that debt allocation across Russian group-affiliated companies cause significant damage to donor companies, as the tunneling hypothesis requires. As a result, we cannot conclude that intra-group loans serve as an instrument for tunneling in Russia.

Table 5. Logit and ordered logit regressions for receivers and providers of intra-group loans.

	(1)	(1a)	(2)	(2a)	(3)	(3a)
Dependent variable	**RECEIVER**	**RECEIVER**	**PROVIDER**	**PROVIDER**	**FINROLE**	**FINROLE**
CFR	0.8536*	0.8031	0.0081	0.0385	−0.4971	−0.4683
	(0.5154)	(0.5188)	(0.5145)	(0.5025)	(0.3744)	(0.3690)
CFR * STATE	0.3414	0.3578	−1.3295***	−1.3408***	−0.8406 ***	−0.8626 ***
	(0.2654)	(0.2606)	(0.2430)	(0.2384)	(0.2138)	(0.2062)
SIZE	−0.0878**	−0.0819**	0.0600	0.0651	0.0827 ***	0.0863 ***
	(0.0400)	(0.0384)	(0.0465)	(0.0460)	(0.0315)	(0.0312)
AGE	0.0205	0.0195	0.0432***	0.0438***	0.0104	0.0109
	(0.0167)	(0.0162)	(0.0151)	(0.0151)	(0.0113)	(0.0112)
TANG	1.1678***	1.2528***	−0.2884	−0.3260	−0.5573 **	−0.5998 **
	(0.4092)	(0.3959)	(0.4070)	(0.4135)	(0.2672)	(0.2629)
LEV	4.2030***	4.3525***	−2.5709***	−2.6208 ***	−4.1769 ***	−4.2381 ***
	(0.5120)	(0.4874)	(0.5726)	(0.5592)	(0.5312)	(0.5283)
FA	0.2363	0.2286	1.9594***	1.9375***	1.0944 ***	1.0754 ***
	(0.4665)	(0.4630)	(0.3973)	(0.3987)	(0.3496)	(0.3475)
ROA	−0.0975		0.3378		0.2865	
	(0.6657)		(0.8016)		(0.5692)	
SG (wins.)	0.0276		0.0106		0.0005	
	(0.0689)		(0.0622)		(0.0454)	
CLR (wins.)	−0.0173		−0.0000		0.0016	
	(0.0243)		(0.0036)		(0.0031)	
Constant	−2.1701***	−2.3376***	−2.3342***	−2.4019***		
	(0.7437)	(0.7235)	(0.7170)	(0.7098)		
Mean for dependent variable	0.2929	0.2929	0.2455	0.2455	0.9526	0.9526

Dependent variable	(1) RECEIVER	(1a) RECEIVER	(2) PROVIDER	(2a) PROVIDER	(3) FINROLE	(3a) FINROLE
SD of dependent variable	0.4554	0.4554	0.4307	0.4307	0.7327	0.7327
McFadden's Pseudo R-Square	0.2325	0.2283	0.1747	0.1744		
Log-Likelihood	–332.7719	–334.6094	–329.7574	–329.9147	–648.5615	–648.8245
AIC	687.5438	685/2189	681.5147	675.8294	1321.123	1315.649
Correct predictions	545 (76.0%)	547 (76.3%)	568 (79.2%)	567 (79.1%)	435 (60.7%)	434 (60.5%)
Likelihood ratio test (p-value)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

* Significance at the 10% level. ** Significance at the 5% level. *** Significance at the 1% level. Standard errors in parentheses.

(wins.) stands for a variable winsorized at the top 1% of its distribution to mitigate the effect of outliers.

Source: Author's calculations.

Conclusion

Summarizing the empirical findings for 2018–2020 obtained on a set of 239 Russian joint-stock companies representing 21 business groups, the authors conclude that the direction of credit flows on the internal capital markets of Russian business groups is mostly dependent on such firm characteristics as company size and age, tangibility of assets, leverage, and share of financial assets in total assets. In line with the financing advantage hypothesis, company size has a negative impact on its probability of being a receiver of inter-group funds, while tangibility of assets and leverage have a positive impact on such a probability. The probability of a company being a provider of intra-group loans is positively related to its age and share of financial assets in the total company assets and is negatively related to company leverage. Though there is evidence that the cash-flow rights of the controlling shareholder have a negative impact on the probability of a company affiliated with a state-owned business group being a provider of intra-group loans, on average, companies providing loans to related parties still are more profitable than receivers of intra-group loans. Finally, our key results do not contradict the previous findings on intra-group lending in Russia obtained on a much more limited sample of Russian group-affiliated companies for the years 2014–2018 [18].

Thus, we can conclude that the results obtained within this empirical study show that the financing advantage motive for intra-group lending is dominant in the leading Russian business groups. In turn, it means that Russian business groups use their internal capital markets as an alternative source of funds that alleviates financing constraints of group-affiliated companies.

References

1. Stein J.C. Internal Capital Markets and the Competition for Corporate Resources. *The Journal of Finance*. 1997;52(1):111-133. DOI: 10.1111/j.1540-6261.1997.tb03810.x
2. Byun H., Choi S., Hwang L., Kim R.G. Business group affiliation, ownership structure, and the cost of debt. *Journal of Corporate Finance*. 2013;23:311–331. DOI: 10.1016/j.jcorpfin.2013.09.003
3. Scharfstein D.S., Stein J.C. The Dark Side of Internal Capital Markets: Divisional Rent-Seeking and Inefficient Investment. *The Journal of Finance*. 2000;60(6):2537-2564. DOI: https://doi.org/10.1111/0022-1082.00299
4. George R., Kabir R., Qian J. Investment–cash flow sensitivity and financing constraints: New evidence from Indian business group firms. *Journal of Multinational Financial Management*. 2011;21:69-88. DOI: 10.1016/j.mulfin.2010.12.003
5. Gupta, G., Mahakud, J. Alternative measure of financial development and investment-cash flow sensitivity: evidence from an emerging economy. *Financial Innovation*. 2019;5(1):1-28. DOI: 10.1186/s40854-018-0118-9
6. Iacobucci D. Internal Capital Market and Investment Decisions in Small and Medium-Sized Groups. In *Small Businesses in the Aftermath of the Crisis. Contributions to Economics*. Heidelberg: Physica; 2012:211-227. DOI: 10.1007/978-3-7908-2852-8_11
7. Mota J.H., dos Santos M.C. Does Internal Capital Market Membership Matter for Capital Allocation?

Theory and Evidence from the Euro Area. CICEE Working Paper No.003/2019. 2019. 53 p. DOI: 10.2139/ssrn.3530191

8. Gopalan R., Nanda V., Seru A. Internal Capital Market and Dividend Policies: Evidence From Business Groups. *The Review of Financial Studies*. 2014;27(4):1102–1142. DOI: 10.1093/rfs/hhu004
9. Gurunlu M. Propping in the Pyramidal Business Groups in Turkey. *Corporate Accounting & Finance*. 2018;29(2):114-126. DOI: 10.1002/jcaf.22329
10. Labhane N.B. Dividend Policy Decisions in India: Standalone Versus Business Group-Affiliated Firms. *Global Business Review*. 2019;20(1):133–150. DOI: 10.1177/0972150918803990
11. Bena J., Ortiz-Molina H. Pyramidal ownership and the creation of new firms. *Journal of Financial Economics*. 2013;108:798-821. DOI: 10.1016/j.jfineco.2013.01.009
12. Masulis R.W., Pham P.K., Zein J. Family Business Group Expansion Through IPOs: The Role of Internal Capital Markets in Financing Growth While Preserving Control. *Management Science*. 2020; 66(11):5191-5215. DOI: 10.1287/mnsc.2019.3418
13. Buchuk D., Larrain B., Muñoz F., Urzúa F.I. The internal capital markets of business groups: Evidence from intra-group loans. *Journal of Financial Economics*. 2014;112:190-212. DOI: 10.1016/j.jfineco.2014.01.003
14. Dewaelheyns N., Van Hulle C. Internal Capital Markets and Capital Structure: Bank Versus Internal Debt. *European Financial Management*. 2010:16(3):345-373. DOI: 10.1111/j.1468-036X.2008.00457.x
15. Jiang G., Lee C.M.C., Yue H. Tunneling through intercorporate loans: The China experience. *Journal of Financial Economics*. 2010;98:1-20. DOI: 10.1016/j.jfineco.2010.05.002
16. Russian Economy in 2018. Trends and Outlooks. Moscow: Gaidar Institute Publ.; 2019. 616 p. (in Russian)
17. Korotkova Y.I. Business groups and their internal capital markets: the foreign and Russian experience. *Moscow University Economic Bulletin*. 2021;5:72–90. (in Russian) DOI: 10.38050/01300105202154
18. Korotkova Y.I. Internal capital market efficiency of business groups. *Problems of Management Theory and Practice*. 2019;7:100-115 (in Russian).
19. Main directions of financial market development in the Russian Federation for 2022 and the period of 2023 and 2024. Moscow: Bank of Russia; 2021. 105 p. (in Russian)
20. Filatov V.I. Financial resources for the growth of the Russian economy. *Mir novoi ekonomiki = The World of New Economy*. 2021;15(2):97-106. DOI: 10.26794/2220-6469-2021-15-2-97-106
21. He J., Mao X., Rui O.M., Zha X. Business groups in China. *Journal of Corporate Finance*. 2013;22:166-192. DOI: 10.1016/j.jcorpfin.2013.05.001
22. Yeh Y.-H., Lin J.J. Investment-cash flow sensitivity to internal capital markets and shareholding structure: evidence from Taiwanese business groups. *Eurasian Business Review*. 2020;1-21. DOI: 10.1007/s40821-020-00157-7
23. Almeida H., Kim C.-S., Kim H.B. Internal Capital Markets in Business Groups: Evidence from the Asian Financial Crisis. *The Journal of Finance*. 2015;70(6):2539-2586. DOI: 10.1111/jofi.12309
24. Tan W., Ma Z. Ownership, Internal Capital Market, and Financing Costs. *Emerging Markets Finance and Trade*. 2016;52(5):1259-1278. DOI: 10.1080/1540496X.2016.1138815
25. Stiebale J., Wößner N. M&As, Investment and Financing Constraints. *International Journal of the Economics of Business*. 2020;27(1):49-92. DOI: 10.1080/13571516.2019.1653719
26. Wang Z., Wang Y. Ownership, Internal Capital Markets, and Cash Holdings, Emerging Markets. *Finance and Trade*. 2019;55(7):1656-1668. DOI: 10.1080/1540496X.2018.1553710
27. Gopalan R., Nanda V., Seru A. Affiliated firms and financial support: Evidence from Indian business groups. *Journal of Financial Economics*. 2007;86:759-795. DOI: 10.1016/j.jfineco.2006.09.008
28. Atanasov V., Bernard B., Ciccotello C., Gyoshev S. How does law affect finance? An examination of equity tunneling in Bulgaria. *Journal of Financial Economics*. 2010;96:155–173. DOI: 10.1016/j.jfineco.2009.12.005
29. Peng W.Q., Wei K.C.J., Yang Z. Tunneling or propping: Evidence from connected transactions in China. *Journal of Corporate Finance*. 2011;17:306-325. DOI: 10.1016/j.jcorpfin.2010.08.002
30. Paligorova T., Xu Z. Complex ownership and capital structure. *Journal of Corporate Finance*. 2012;18:701–716. DOI: 10.1016/j.jcorpfin.2012.05.001
31. Teplova T.V., Krylova M.S. The empirical research of the factors determining the investment activity of Russian companies. *Journal of Corporate Finance Research*. 2007;1(1):22-48 (in Russian). DOI: 10.17323/j.jcfr.2073-0438.1.1.2007

The article **was submitted** 16.12.2021; **approved after reviewing** 16.01.2022; **accepted for publication** 28.01.2022.

DOI: https://doi.org/10.17323/j.jcfr.2073-0438.16.1.2022.14-37
JEL classification: O34, G34

Impact of Intellectual Property Rights on Activity of Cross-Border Mergers and Acquisitions

Ksenia Zykova
Commercial Business Controller,
Lantmännen Unibake, Copenhagen, Denmark,
ksenija-zykova@yandex.ru, ORCID

Abstract

We studied the impact of the IPR (intellectual property rights) protection in the target and acquirer countries on the intensity of inbound cross-border M&As (mergers and acquisitions) in the target countries on a sample of 509 216 cross-border and domestic M&As in 64 developed and developing countries over 1985–2017. Our results show that better IPR protection in the target countries has a positive impact on M&A activity for the targets from the emerging and developed markets. We also discovered an inversed U-shaped relationship between the IPR protection in target countries and cross-border M&A activity at the post-TRIPS period after the global increase in IPR protection. Our results also show that acquirers from developed countries make fewer cross-border M&A deals when IPR protection improves in their own countries. The opposite happens when IPR protection improves in the countries of the emerging acquirers, who acquire targets from developed countries. IPR protection in the emerging targets motivates developed acquirers to make more international M&A deals, while the opposite happens when developed acquirers seek to purchase targets from developed markets.

Keywords: intellectual property rights, cross-border mergers and acquisitions, gravity model, international comparison, world economy

For citation: Zukova, K. Impact of Intellectual Property Rights on Activity of Cross-Border Mergers and Acquisitions. *Journal of Corporate Finance Research*. 2022;16(1): 14-37. https://doi.org/10.17323/j.jcfr.2073-0438.16.1.2022.14-37

Introduction

Economies are becoming more innovative, the importance of intellectual capital is increasing, and cross-border mergers and acquisitions (M&A) are growing increasingly more tied to intellectual property with each year. In modern economy, acquirers are usually as interested in exporting their intellectual property (technologies, patents, trademarks and others) to foreign target companies, as in importing it from target firms. Thus, when entering foreign markets, acquirers are specifically concerned about intellectual property rights (IPR) protection in target countries. Intellectual property assets can be a significant part of the target's value, they affect the acquirers' decisions and can be a driving force behind both cross-border and domestic M&A deals [1].

The issue of IPR protection is in the center of the policy and free trade agreement discussions around the world due to the complexity of its influence on national economies. While some authors state that strong IPR protection is crucial because it reduces the probability of imitation or theft and encourages companies to invest in research and innovation [2–5], others think that strong IPR protection discourages innovation and decreases economic growth [6–9].

Some aspects of the connection between IPR and M&A were covered in only two papers by Campi et al. and Alimov and Officer [1; 10]. Based on a sample of domestic and cross-border M&A deals both in developed and emerging capital markets, the authors found a positive influence of IPR protection on cross-border inbound M&A activity in target countries. Alimov and Officer also noticed that IPR protection has a higher influence on M&A activity in the industries that are more intellectual capital-intensive and where IPR are more important for production. This influence is stronger when the target country has weaker IPR protection than the acquirer country. Besides, the increase in the Patent Index of a target country is positively associated with the synergy gains of cross-border M&A [10].

Our research makes several contributions to the existing academic literature. First, we compare the impact of IPR protection on inbound M&As for developed and emerging target countries separately since IPR protection differs significantly in these markets. Second, we check for the existence of an optimal level of IPR protection in terms of inbound M&As for different target countries. Third, we find new logics of bilateral M&A flows depending on the type of target and acquirer countries. Fourth, we try to find new proxies to measure the IPR protection level. Finally, our empirical analysis covers the period until 2017, meaning that we are examining a more recent period in contrast to preceding studies.

This research is interdisciplinary and integrates macroeconomics, international trade, and corporate finance. To test the proposed hypotheses about the impact of IPR protection in the target and acquirer countries on the intensity of inbound cross-border M&As in the target countries, we used the regression analysis in form of panel data with fixed effects, built on the basis of ordinary least squares. We suggested two models and gathered a dataset of more than 500 000 M&A deals conducted in 64 countries between 1985 and 2017.

This study is organized as follows. Review of literature on the connection between IPR and M&A and Hypotheses are presented in Section 2. Methodology is proposed in Section 3. Section 4 presents the data description and summary statistics. The empirical results about the connection of IPR protection and inbound M&A in target countries are contained in Section 5. Section 6 comprises robustness checks, and conclusions are presented in Section 7.

Literature review & hypotheses

Cross-border M&A deals increasingly involve intellectual property (IP) because it is important for the acquirers to protect their IP when they buy the targets in foreign markets and export technologies, trademarks and other IP to improve the targets' performance.

The most common reason for cross-border and domestic M&A is the increase in business value, which is usually reached through synergies [11]. Several research studies note that highly valued companies tend to purchase lower valued ones due to misvaluation [12–14], and the companies from wealthier countries tend to purchase firms from poorer countries due to the lower cost of capital [11; 15]. Ahern et al. state that cross-border M&A can potentially generate greater value than domestic deals due to a larger pool of potential partners, greater growth potential, potentially more efficient distribution systems or improvement of managerial problems, which results in greater synergies. At the same time, the risks of cross-border M&A are also higher due to cultural and legal differences, political reasons and other factors [16].

The value of IP in the foreign country for the acquirer depends on how well it is protected there: the value is higher if the regulations make it hard to copy and steal IP. Besides, IPR protection has a complex impact on the economies, balancing the costs and benefits of protection, and placing it in the focus of discussions nowadays. Since the importance of IPR protection in international M&A deals is increasing, it is important to understand the impact of IPR protection on cross-border M&A activity on the emerging and developed markets.

One of the basic research studies about the effect of IPR on cross-border M&A was conducted by Alimov and Officer. The authors study a set of 50 largest countries in terms of M&A from 1985 to 2012 and find that there is an increase in cross-border inbound M&A after a country reinforces its IPR. This finding can be intuitively explained: the investors can benefit from owning intellectual property abroad only if it is protected and there is a low risk of its copying or imitation. In addition, IPR have an influence on M&A activity only in the industries that are more intellectual capital-intensive and where IPR are have a greater significance for production. Moreover, this influence is stronger when the target country has weaker IPR protection than the acquirer country, which means that investors

are more concerned with IPR protection when they buy companies from emerging countries with less developed IPR protection than in their own countries. Besides, the authors found that an increase in the Patent Index of a target country is positively associated with the synergy gains of cross-border M&A. It is explained by the fact that better protected intellectual capital of the target is more valuable for the investors from other countries [10].

Another research study of the direct connection between IRP and M&A was recently conducted by Campi et al. The authors estimate the extended gravity model to study the bilateral number of M&A for both developed and emerging countries during the post-TRIPS period of 1995–2010. They find that IPR and law enforcement have a positive influence on cross-border M&A in all sectors regardless of their technological content, but IPR is more important in high-technology sectors. In addition, the reinforcement of IPR stimulates a greater increase in M&A in emerging countries than in developed ones [1].

Same as Campi et al. and Alimov and Officer, many researchers note that it is important to consider country characteristics when investigating cross-border M&A and FDI [1; 10]. Erel et al. find that different factors can have smaller or larger impact on inbound M&A depending on the level of a country's development. More specifically, they prove that stock and currency return differences between target and acquirer countries have a bigger impact if the acquiring country is wealthier [11]. Hsu and Tiao also mention that different country characteristics may have a significant influence on inward FDI and, hence, cross-border M&A [17].

IPR protection is a part of institutional conditions in the countries, and these conditions affect the inbound cross-border M&A. Countries with civil legal origin, higher investor protection, weak enforcement of insider trading laws, less developed stock markets, better accounting standards and stronger shareholder protection are more attractive in terms of cross-border M&A [14; 18; 19]. Hostile deals and higher premiums are more common in target countries with better shareholder protection because strong protection of minority shareholders makes control more contestable, while all-stock deals are more common in acquiring countries with better shareholder protection [14]. Cross-border M&A activity worldwide is higher when the target country has a weaker legal environment [18].

Medium and high levels of foreign institutional ownership increase the intensity of cross-border M&A, and this effect is stronger in the countries in less developed markets with weak legal institutions. The reason for this is the role of foreign investors, who build bridges between target and bidder companies and reduce transaction costs, bargaining costs, and information asymmetry between them. Such investors are even more important when the market barriers are high [18].

Therefore, IPR protection is an important factor in cross-border M&A activity, and is likely to be positively related to inbound M&A, especially in emerging countries and intellectual capital-intensive industries. However, IPR protection is not the only factor that has an influence on cross-border M&A activity, and it is important to consider other factors as well.

Based on the literature review, it is possible to introduce certain hypotheses about the influence of IPR protection on inbound cross-border M&A activity in the developed and emerging countries.

Hypothesis 1: IPR protection has a positive impact on inward cross-border M&A.

Strengthening of IPR through intellectual property reforms should increase the inbound cross-border M&A because, as it is described above, the investors can benefit from owning intellectual property abroad only if it is protected and there is a low risk of its copying or imitation [1; 10]. Intellectual property rights can be measured though the Property Rights index developed by Ginarte and Park, which is the most common index used in research studies [20]. In addition, there is the International Property Rights Index developed by the Property Rights Alliance.

Hypothesis 2: IPR protection has a stronger positive impact on inbound cross-border M&A in the emerging countries than in the developed ones.

Institutional factors have a bigger impact on the intensity of cross-border M&A in the countries from less developed markets with weak legal institutions [18]. IPR are one of the institutional factors, so they are expected to have a stronger positive influence on inbound cross-border M&A [10; 18]. The emerging countries have a lower level of IPR protection, while the developed countries have high IPR protection, so the marginal increase in IPR protection has a bigger impact for emerging countries [17; 21].

Hypothesis 3: IPR protection has an optimal level for inbound cross-border M&A in the emerging and developed markets.

On the one hand, stronger IPR protection can have a positive effect on international investments because it decreases the threat of imitation by local companies and provides high returns to the R&D investments of foreign companies, which makes a host country more attractive for foreign investors [17]. On the other hand, stronger IPR protection can decrease international investments if it results in an increase in monopoly power of foreign businesses. Therefore, patent protection has a negative effect on social welfare and inbound investments when protection is excessive, and a positive effect after a certain level of IPR strength is reached. There should be an optimal level of IPR protection, which balances the costs and benefits of protection [3; 7; 19–23]. This level should be lower for emerging countries due to their smaller markets and lower technological capabilities [3; 17].

Hypothesis 4: IPR protection has a stronger positive impact on inbound cross-border M&A if the target country has weaker IPR protection than the acquirer country.

Different factors can have smaller or larger impact on inbound M&A depending on the level of countries' devel-

opment [11; 17]. Investors are more concerned with IPR protection when they buy companies from emerging countries with less developed IPR protection than in their own country [10].

Methodology

There are several models that should be used to check the proposed hypotheses about the relationship between the strength of IPR protection in the countries and the intensity of inbound cross-border M&A. The basic idea is to use the OLS panel regressions with fixed effects for countries or country-pairs and years where appropriate [4; 10; 24].

Fixed effects models remove permanent country-level characteristics, which can be correlated with cross-border M&A activity and ensure that the estimated influence of IPR protection on cross-border M&A is identified from within-country variation in intellectual property protection over time, rather than from simple cross-country correlations. Thus, fixed effects models capture the variation in shocks to IPR within the same countries and help to address the omitted variables problem [10; 11; 14; 16–18; 25; 26]. The regressions also include the institutional, economic and financial characteristics of the countries.

We use two different datasets. The first sample is for target countries with the information about the number and volume of cross-border inbound M&A to target countries. Another sample is for country-pairs, where information about M&A activity is collected for target countries from each specific acquirer country. It is done to capture the information not only about target countries, as in the first dataset, but also about acquirer countries. Mainly, it helps to check if IPR protection in an acquirer country has an impact on cross-border inbound M&A to target countries.

The dependent variable at the country level is the logarithm of one plus the total number of cross-border M&A in a target country, and at the country-pair level, it is the logarithm of one plus the total number of cross-border M&A in a target country by each specific acquirer country [10; 11]. The number of M&A deals is a better proxy of general M&A activity in the countries than deal volume, since only about one-third of the deals have a disclosed value and the value is mostly disclosed for the deals in the developed countries, which can make the results biased [1; 10].

The key independent variable of interest is the strength of patent rights protection, which is measured through the Index of Patent Strength of Ginarte and Park. This index is used by many authors to investigate the influence of IPR on innovation, FDI, M&A, trade, technology diffusion and other economic variables [2; 3; 8; 10; 17; 23; 26–28], and was developed by Ginarte and Park [20] and updated in Park [29] for more than a hundred countries since 1960.

The index is measured once every 5 years and consists of five components, which have several conditions. If these conditions are satisfied, the level of protection is high in that category. Each condition is binary, and each category takes the value from 0 to 1. Therefore, the general index can fluctuate between 0 and 5. The five components are the following: extent of coverage (represents patentability of different inventions, or how many categories of inventions can be patented), membership in international patent agreements (shows the adoption of certain IP laws), provisions for loss of protection (refers to less than exclusive use of protection, or the probability of losing patent rights due to obligatory requirements), enforcement mechanisms (refers to mechanisms that aid in enforcing patent rights), duration of protection (shows the term of patent protection) [10; 20].

There is also the Index of Property Rights Protection, which is a part of the International Property Rights Index developed by the Property Rights Alliance since 2007. Index of Property Rights Protection includes protection of intellectual property rights, patent protection and copyright piracy components. The International Property Rights Index also includes the Legal and Political Environment Index (judicial independence, rule of law, political stability and control of corruption) and Physical Property Rights Index (protection of physical property rights, registering property and ease of access to loans). This index includes not only the property rights aspects, but also the institutional aspects, it is more common in the non-academic sphere and it is easier to get an access to it.

The Index is created with five-year intervals, so it is possible to use the three to five-year averaged values of the Index [19], or each year should be matched to the closest index [10]. For example, the Index for 2010 is used for 2012, but for 2013, it is the Index for 2015. In this research we adhere to the second method, which makes it possible to extend the research period until 2017.

The models include the country fixed effects, which absorb permanent country characteristics, so only variables that change over time should be included. Control variables should be lagged by one year to avoid endogeneity problem [10; 26]. The description of all the variables, including control variables, is available in *Appendix 1*.

The basic model for countries is an OLS panel regression with fixed effects for target countries and years. The model is as follows:

$$Log\left(1+Cross-border\ M\ \&\ A_{tgt,t}\right)=$$
$$=+\beta_1\times Patent\ Index_{tgt,t-1}+$$
$$+\beta_n\times Controls\ for\ countries_{tgt,t-1}+\omega_{tgt}+\mu_t+\varepsilon_{tgt,t}, \quad (1)$$

where *tgt* stands for target countries, t stands for the year, ω_{tgt} is a country fixed-effect, μ_t is a year fixed-effect. Control variables are the following: logarithm of one plus target GDP per capita, GDP growth, market return, trade openness, financial market development and credit market development, exchange rate (to UDS), logarithm of one plus the number of domestic deals.

The basic model for country-pairs is an OLS regression with fixed effects for target and acquirer countries and years. The model is as follows:

$$Log\left(1+Cross-border\ M\ \&\ A\ in\ country-pairs_{tgt,acq,t}\right)=\alpha+\beta_1\times Patent\ Index_{tgt,t-1}+$$
$$+\beta_2\times Patent\ Index_{acq,t-1}+\beta_n\times Controls\ for\ country-pairs_{tgt-acq,t-1}+\omega_{tgt}+\omega_{acq}+\mu_t+\varepsilon_{tgt,acq,t},\quad (2)$$

where *tgt* stands for target countries, *acq* stands for acquirer countries, *t* stands for the year, $\omega_{tgt,acq}$ is a country fixed-effect, μ_t is a year fixed-effect. The countries should be split into four subsamples dependent on the developed or emerging economies of target and acquirer countries (this classification can be obtained from the World Bank database). In this model, control variables are different from those in the model for separate countries, and they are as follows: GDP per capita difference for target and acquirer, GDP growth difference, market return difference, financial market development difference and credit market development difference, exchange rate relationship. Additional control variables include geographical distance between target and acquirer countries, cultural distance, and dummy variables for colony relationships in the past, common law, common religion and common language.

To summarize, OLS panel regression models with fixed effects for the countries, country-pairs (where appropriate) and years should be used for the empirical check of the proposed hypotheses about the relationship between IPR protection and cross-border M&A.

Data and Summary Statistics

The sample consists of M&A from 64 developed and developing countries that are the most active in terms on M&A between 1985 and 2017 based on the dataset collected by the author of this research (the list of these countries with the number of deals is provided in *Appendix 2*). The Patent Index is measured starting in 1960, but the 1985–2017 time period was selected because a sufficient number of yearly cross-border M&A deals was reached since 1985 for a sufficient number of countries. The M&A sample was collected from Thomson Reuters Eikon database, macroeconomic and cultural data was collected from the World Banks, CEPII, CIA World Factbook, World Values Survey, and the article by Stulz and Williamson [30]. The list of M&A deals with corresponding information was collected, and subsequently transformed into a pivot table, where the information about separate M&A deals was transformed into the sum of the numbers or volume of M&A deals for each target country or country-pair in each year. For example, the list of 366 inbound M&A deals in Germany in 2000 was only turned into the number "366" in the pivot table. Then other data like Patent Index and control variables was added to the final pivot tables (there were different pivot tables for target countries and country-pairs), which were used in regressions.

According to the approach of Alimov and Officer, Erel et al. and other authors, only international M&A deals were examined (without spinoffs, LBOs, recapitalizations, repurchases, partial equity stakes, self-tender and exchange offers, acquisitions of remaining interest, privatizations and deals with government acquirers or targets). Both private and public targets and deals with both disclosed and undisclosed value can be included because the main focus is on the aggregate M&A activity rather than individual deals [10; 11].

At the country-pair level, each country pair means a specific target country in the first place and a specific acquirer in the second place. For example, if German companies buy Chinese companies and vice versa, these are two pairs of countries: Germany-China and China-Germany. Only country pairs with 3 and more deals within the sample period remained in the dataset, as many country pairs didn't have cross-border deals with each other [10].

The final sample includes 509 216 cross-border and domestic M&A deals with total disclosed value of $41.4 trillion. Domestic deals are included in the sample because they were initially used as a control variable in the regressions and are used in robustness checks. 115 905 or 23% of the M&A deals are cross-border deals with total disclosed value of $11.9 trillion. In almost 57% of cross-border deals transaction value is not disclosed. Importantly, it happens more often when the countries participating in a deal are emerging ones. Therefore, the number of deals, rather than their value, is used as a measure of M&A activity. In cross-border M&A deals, very few targets (5%) are public firms, while there are many more public acquirers (56%). Most of the deals are diversifying (63%), where the acquirer and target companies are from different industries, and there are almost no hostile deals (less than 1%). Deal characteristics are similar for cross-border and domestic M&A, as shown in Table 1.

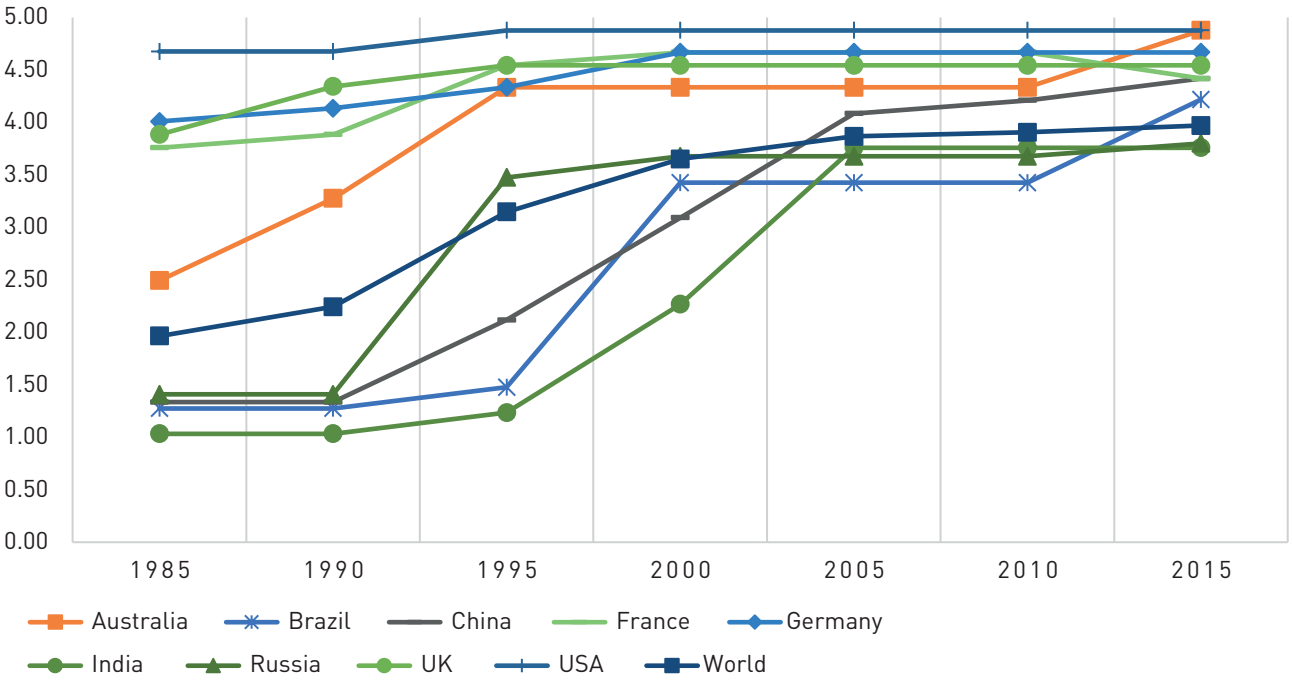
It is important to mention that due to the data collection method (mentioned above) and turning the list of M&A deals into the number of country-year or country-pair-year cross-border M&A deals, 115 905 cross-border M&A deals turn into 2112 country-year observations or 42 504 country-pair-year observations.

Table 1. Deal-level summary statistics (%)

Variable	Inbound c-b M&A	Domestic M&A	Total
Total number of cross-border deals	115 905	393 311	509 216
Transaction value ($ trillion)	11.9	29.5	41.4
Deal with disclosed transaction value	43	42	42

Variable	Inbound c-b M&A	Domestic M&A	Total
Acquirer is a public firm	56	45	47
Target is a public firm	5	6	6
Diversifying deal	63	60	61
Hostile deal	0.1	0.1	0.1

Figure 1. The evolution of Patent Index from 1985 to 2015



Appendix 2 represents the detailed information about the countries in the sample with information about domestic, inbound and outbound cross-border M&A deals along with the average economy size and the level of Patent Index. The information about all kinds of M&A deals is needed to see how active different countries are in terms of different types of M&A. The United States, the United Kingdom, Canada, Germany and France are the most active cross-border acquirers, and they are the most attractive destinations for cross-border M&A deals. The same countries are the most active in terms of domestic M&A along with Japan. Notably, the number of M&A deals in the United States vastly exceeds the number of deals in any of the other 63 countries. It is interesting to notice that emerging countries have the highest imbalance between inbound and outbound M&A deals compared to the total number of cross-border deals (Romania, Ukraine, Ecuador, Vietnam, Uruguay, Indonesia, Hungary, Argentina and so on).

The country with the weakest IPR protection in 2017 is Venezuela (2.44). Historically, the country with the highest Patent Index was the United States, but in 2017 it has the highest IPR protection along with Australia and Finland (4.88). In general, the Patent Index is an indicator of economic wealth, although exceptions exist. For example, India is the 2nd poorest country in the sample with the average GDP per capita lower than $756, but India's patent strength on 2017 is in the first quartile (3.67).

Average Patent Index from 1985 to 2017 is 3.33. Over time, most of the countries have significantly improved their IPR protection, and most of the countries keep improving it. The average Patent Index increase from 1985 to 2017 is 2.01. The most significant increase happened in Colombia (from 0.96 to 4.42) and Costa Rica (from 1.16 to 4.42). However, in the recent years some developed countries, including Belgium, France, Luxembourg and New Zealand, with traditionally high IPR protection have loosened their IPR protection. In the United States and the United Kingdom, the Index has remained static and relatively high for many years.

Figure 1 documents the evolution of the Patent Index between 1985 and 2015 for several representative countries from the sample and for the world on average. The Index is determined once in 5 years for each country. It is apparent that the IPR protection is generally improving in all countries with some exceptions, which are mentioned above. It is important to note that signing the agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS) in 1994 led to global diffusion

and improvement of IPR systems. After that, even developed countries increased the level of IPR protection and emerging ones adopted new systems or adapted existing systems to the minimum standards demanded by TRIPS [1].

Appendix 3a presents the detailed summary statistics for the dependent, key independent and control variables used in the regression models for the country-level. On average, there are 55 inbound cross-border deals in a country per year with total disclosed deal volume of $5.6 billion. Average Patent Index for a target country is 3.33, average GDP per capita is $17 000 and total GDP growth is 3% per year. The average trade openness (sum of imports and exports to GDP) is 76%, local stock market return is 10%, financial market development (market capitalization to GDP) is 49%, and credit market development (private loans to GDP) is 74%. Average national exchange rate scaled by 100-dollar CPI is 4.13 and the average number of domestic M&A deals is 186 deals in a country per year. The dynamics of these variables is shown in *Appendix 4*.

It is possible to see that some variables are distributed unevenly between different quartiles as they are driven by some highly developed countries. This is considered in the empirical calculations, and the results are robust to changing the country dataset, which is demonstrated further.

As to the dataset for the country-pairs, summary statistics about some variables is shown in *Appendix 3b*. The average number of deals between each country pair per year is 3 with the total disclosed deal volume of $273 million. Average Patent Index for the target country (3.58) is lower than for the acquirer country (3.90), as expected. Target countries have lower GDP, higher GDP growth, higher market return and lower financial and credit market development, according to theory. The average distance between M&A country pair is 5550 kilometers and their cultural difference (what percent of respondents state that other people can be trusted) is 24%. 6% of country pairs have a colonial relationship in their past, 27% of country pairs have common laws, 31% – the same religion, and 18% – common language.

Correlation between variables at the country-level is shown in *Appendix 5a*. There is no correlation between different variables, which is higher than 58%. Thus, no multicollinearity is expected in the models. Correlation table indicates that the number of inbound cross-border M&A deals has a positive and significant relationship with the Patent Index, which supports the proposed hypothesis about the positive influence of the Patent Index on inbound cross-border M&A in the target country. In addition, the number of deals have a positive relationship with GDP per capita, number of domestic deals, financial market and credit market development and negative relationship with GDP growth and exchange rate, which is consistent with theory. It also has a negative relationship with trade openness and market return, which is inconsistent with theory.

Correlation matrix for the country-pair level is presented in *Appendix 5b*. The maximum correlation between variables is 45%, so no multicollinearity is expected in the models. The number of inbound cross-border M&A deals is positively and significantly related to target and acquirer countries' Patent Index, which supports the proposed hypotheses. In addition, there is a positive and significant relationship between the number of inbound cross-border deals with GDP per capita difference, GDP growth difference, common religion and language. On contrary, there is a negative and significant relationship with the financial market development difference, geographical distance and cultural difference.

To conclude, summary statistics indicates that better IPR protection positively affects the number of inbound cross-border M&A deals and shows that generally, control variables affect M&A intensity according to theoretical assumptions.

Empirical Results

Empirical analysis is conducted using two kinds of models: for country level and for country-pairs. Each model is presented in several specifications, and the difference between them is described further.

Country Level Model

The model for the country level should be used to test Hypotheses 1, 2 and 3. The main estimation results are presented in Table 2.

Model (1) is the benchmark specification with control variables, which analyzes the number of inbound cross-border M&A in 64 countries of the dataset, where Patent Index is the only independent variable. The estimates indicate that intellectual property reforms, which result in an increase of the Patent Index, are positively and significantly related to the number of inbound cross-border M&A deals for the targets both in emerging and developed markets. The Patent Index coefficient for all country samples is 0.23, and it is significant at a 1% level. This means that if the patent index increases by 1 point, the number of inbound cross-border deals will increase by 23% on average, which supports the Hypothesis 1 for the emerging targets at the 1% significance level. So, *Hypothesis 1 about a positive impact of IPR protection on inbound M&A deals is not rejected at the 1% significance level.*

The results can also be expressed in a different way, by calculating predicted changes in the number of inbound cross-border M&A deals that would result if a typical sample country in the 25th percentile of the Patent Index distribution (2.65) improved its Patent Index by 59% to the level of an emerging country in the 75th percentile of the Patent Index distribution (4.22). The Patent Index coefficient from the *Model (1)* is 0.23, so the inter-quartile growth in IPR protection expressed through the Patent Index would raise the annual number of inbound M&A deals by 14%. The average number of inbound M&A deals per year is 55, which translates to a increase of 8 deals per year, an economically significant effect. The average volume of one inbound M&A deal is $103 mln, so this increase of

IPR protection brings in $824 mln every year, which is equivalent to 1% of the yearly GDP of such countries from the sample as Bulgaria, Lithuania, Kenya, Uruguay and so on. Therefore, the impact of changes in IPR protection on cross-border M&A is not only statistically significant, but also economically important.

However, by looking at the regression results and standard errors of the Patent Index coefficients, it is impossible to say that the impact of IPR protection is higher for the targets from emerging markets than for the targets from developed ones. It means that *Hypothesis 2 about a stronger positive influence of IPR protection on inbound M&A deals in emerging markets is rejected.*

Regarding control variables:

- GDP growth has a significant positive impact on inbound cross-border M&A deals: an increase in GDP growth increases the number of inbound M&A deals in a target country. This finding is consistent with theory, as faster growing markets are more attractive for cross-border M&A investors.
- The number of domestic M&A deals has a similar effect: a 1% increase in the number of domestic M&A deals increases the number of inbound cross-border deals by 28%. If the target country is active in terms of domestic M&A, it is likely that it is also an attractive target for foreign investors.
- The exchange rate has a positive impact: if the national currency of the target country depreciates, the companies become cheaper for foreign investors.

Model (2a) represents the specification that includes the squared Patent Index. In the 1985 dataset, the Patent Index is positive and significant in relation to the number of inbound M&A, however the squared Patent Index is negative and not significant. It means that there is no non-linear relationship during that period: the higher the Patent Index, the better the situation is in terms of M&A. However, academic literature cites both positive and negative consequences of very strong IPR protection.

As mentioned above, the signing of the TRIPS agreement in 1994 led to global diffusion and improvement of IPR systems. If a dataset of the post-TRIPS period between 1995 and 2017 is selected *(Model (2b),* the squared Patent Index for the emerging countries becomes negative and significant. During this period IPR protection started reaching very high levels and some disadvantages of overly strong IPR protection began to emerge. Summary statistics supports it, since there are several countries whose Property Index has increased in the recent years. Therefore, *Hypothesis 3 about the inversed U-shape relationship between IPR protection and inbound M&A activity has not been rejected since 1995 at the 1–10% significance level.* By examining the coefficients in *Model (2b),* we can state that the optimal level of IPR protection for emerging countries is 3.4, and for developed countries is 3.6 in current specification (this difference is subsequently tested in the robustness checks), which is consistent with the theory that developed countries have a higher IPR protection level. We can also see that the IPR index rose quite high for many countries, and some developed countries with traditionally high IPR protection have loosened their IPR protection in the recent years (Belgium, France, Luxembourg and New Zealand). It supports the finding about the existence of an optimal IPR protection level .

There is an alternative proxy for IPR protection measurement – the International Property Rights Index developed by the Property Rights Alliance in 2007. This index is used instead of the Patent Index by Ginarte and Park in the empirical analysis *(Model (4),* and the results do not show a significant impact of this Index on inbound M&A. It means that the International Property Rights Index developed by the Property Rights Alliance is not a suitable measure of IPR protection in connection with M&A activity.

The Patent Index contains five components, so each component can be used instead of the Patent Index in order to understand what aspects of IPR protection have the biggest impact on cross-border M&A activity. The results are presented in Table 3 *(Model (4)*, control variables are the same as in *Model (1)* and coefficients for them are omitted. Membership in international patent agreements and duration of protection have a positive impact at 1–5% significance level for inbound M&A deals for targets both from the developed and emerging markets, while other components of IPR protection are not significant. It is explained by the fact that the acquirers are concerned by the possibility that violations of acquired intellectual property in the other country may be enforceable in their home country.

Table 2. Country-level analysis of IPR protection and cross-border M&A connection. Model (1): base case regression with control variables; Model (2a): base case regression with squared Patent index from 1985; Model (2b): base case regression with squared PI from 1995; Model (3): base case with PI by Allience instead of Patent Index by Ginart and Park

Variables	Model (1): All	Model (1): Em.	Model (1): Dev.	Model (2a): All	Model (2b): All	Model (2b): Em.	Model (2b): Dev.	Model (3): All
				Log C-b Deal Num.				
Patent Index	0.225***	0.198***	0.255***	0.528***	0.707**	0.711**	0.826*	-0.002
	(0.045)	(0.058)	(0.081)	(0.111)	(0.267)	(0.333)	(0.478)	(0.017)
Patent Index Squared				–0.065	–0.104***	–0.105**	-0.115*	
				(0.023)	(0.037)	(0.047)	(0.067)	
Log GDP Per Capita	–0.557	–1.141	0.380	–0.183	–0.600	0.602	0.076	-0.773
	(0.497)	(1.755)	(0.401)	(0.493)	(0.576)	(1.927)	(0.536)	(0.881)
GDP Growth	1.008**	1.200**	–1.300	0.931*	1.687***	1.814***	-0.437	1.991***
	(0.501)	(0.544)	(1.041)	(0.493)	(0.487)	(0.557)	(1.059)	(0.633)
Trade Openess	0.105	0.029	0.092	0.077	0.063	–0.037	0.087	0.146
	(0.073)	(0.166)	(0.073)	(0.075)	(0.079)	(0.221)	(0.082)	(0.203)
Market Return	0.014	0.003	0.052	0.013	–0.073	–0.101*	0.084	-0.011
	(0.070)	(0.077)	(0.097)	(0.075)	(0.049)	(0.051)	(0.098)	(0.046)
Financial Mar. Dev.	–0.026	–0.026	–0.021	–0.009	–0.010	–0.021	-0.003	-0.039
	(0.030)	(0.160)	(0.028)	(0.033)	(0.032)	(0.118)	(0.031)	(0.037)
Credit Mar. Dev.	–0.037	–0.008	0.006	–0.019	0.054	0.087	0.109	-0.145
	(0.115)	(0.184)	(0.136)	(0.114)	(0.116)	(0.200)	(0.126)	(0.088)
Exchange Rate	0.002**	0.001	0.038*	0.001	0.004	0.004*	0.026*	-0.001
	(0.001)	(0.001)	(0.021)	(0.001)	(0.003)	(0.002)	(0.013)	(0.004)
Log Dom. Deal Number	0.282***	0.346***	0.185***	0.294***	0.205***	0.260***	0.066*	0.079
	(0.029)	(0.034)	(0.041)	(0.028)	(0.037)	(0.041)	(0.035)	(0.048)
Constant	0.127	–0.135	0.389	–0.137	0.994*	0.403	1.600*	3.504***
	(0.126)	(0.132)	(0.275)	(0.156)	(0.552)	(0.649)	(0.899)	(0.383)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2048	1056	992	2048	1472	759	713	704
R-squared	0.779	0.790	0.798	0.782	0.449	0.483	0.479	0.141

Robust standard errors in parentheses; Significance *** p<0.01, ** p<0.05, * p<0.1.

Table 3. Country-level analysis of IPR protection and cross-border M&A connection. Model (4): regression with 5 PI components instead of total PI

Variables	Model (4): All	Model (4): Em. Log C-b Deal Num.	Model (4): Dev.
PI Durat. of Protection	0.669***	0.612**	1.017***
	(0.193)	(0.243)	(0.320)
PI Enforcement Mech.	0.025	–0.132	0.054
	(0.093)	(0.141)	(0.094)
PI Loss of Protection	–0.321	0.026	–0.650
	(0.218)	(0.313)	(0.205)
PI Memb. in Agreements	0.606***	0.616**	0.621**
	(0.190)	(0.259)	(0.283)
PI Extend of Cover.	0.165	–0.016	0.297
	(0.231)	(0.281)	(0.259)
Year FE	Yes	Yes	Yes
Country FE	Yes	Yes	Yes
Observations	2048	1056	992
R-squared	0.787	0.796	0.817

Robust standard errors in parentheses; Significance *** p<0.01, ** p<0.05, * p<0.1.

To sum up, IPR protection has a positive impact on the number of inbound cross-border M&A deals for the targets from the emerging and developed markets. There is an inverse U-shaped relationship between IPR protection and the amount of cross-border M&A deals in the post-TRIPS period, when IPR protection improved significantly worldwide, and countries started dealing with the benefits from IPR protection, as well as its drawbacks. The optimal level of IPR protection for the emerging countries is lower than for the developed ones. Among the Patent Index components, membership in international patent agreements and duration of protection are the only IPR index components that have a positive impact on cross-border M&A activity. There was an attempt to find another proxy for IPR protection, such as the Index of the International Property Rights Index developed by the Property Rights Alliance, but so far, the Patent Index by Ginarte and Park is the best proxy to measure IPR protection level.

Country-Pair Level Model

The model for country pairs should be used to test Hypothesis 4. The main estimation results are presented in Table 4. The model is used for four combinations of the countries: emerging targets and developed acquirers; emerging targets and emerging acquirers; developed targets and developed acquirers; developed targets and emerging acquirers.

The results indicate that developed acquirers are 5.4% more likely to buy emerging targets with 1-point improved IPR protection, which proves the findings by Alimov and Officer: acquirers care about IPR protection more when they enter less developed markets because they are concerned about technology and idea imitations in the less protected emerging markets [10]. It means that *Hypothesis 4 about a stronger positive impact of IPR protection on inbound M&A activity if the target country has weaker IPR protection than the acquirer country, is not rejected at the 1% significance level.*

The same happens when IPR protection improves in the emerging acquirers' markets. Emerging acquirers with 1-point higher IPR index are 8.5% more interested in acquisition of targets from the developed markets. It probably happens because the investors from the emerging acquirer countries get used to new standards after IPR protection improvement and they feel ready to enter new developed markets, where IPR protection is likely to be stronger.

On the contrary, when developed acquirers consider buying targets, acquirers' IPR protection improvement by 1 point decreases the number of purchased emerging targets by 5.4% and that of developed targets – by 6.1%. It can be explained by the fact that acquirers are more interested in staying at their own markets with improved IPR protection rather than going to other markets without IPR improvements.

Besides, a 1-point IPR improvement in the developed targets discourages developed acquirers from cross-border M&A by 5.8% because IPR protection is already quite high in the developed markets and it does not bring any benefits if it increases more.

Regarding the control variables:

- If GDP growth in an emerging target country becomes higher than in a developed acquirer country, the number of cross-border M&A deals increases: the investors are attracted to the faster growing markets.
- If the market return in a target country becomes lower than in the acquirer country, it will lead to less cross-border M&A deals.
- If the financial market development in a target country is weaker than in the acquirer country, it discourages investors from cross-border M&A deals.
- If the local currency in a target country becomes cheaper in relation to the currency of an acquirer country, it stimulates foreign investors because they can afford to buy more for the same amount of their local currency.
- According to the gravity model, countries trade with and invest in each other less if they are far from each other; this is supported by the strongly significant and positive coefficients of distance.
- Cultural difference has an effect similar to geographical distance.
- If a country pair had a colonial relationship in the past, it increases the number of annual M&A deals between them because the countries have strong historical bonds and some common characteristics.
- Common law increases M&A activity in a target couple since it is clear to investors what laws are implemented in a target country.
- Common religion increases M&A activity since countries are mentally close to each other.
- Finally, common language increases M&A activity since it is easier for companies to negotiate if they speak the same language.

To sum up, better IPR protection in the target countries has a positive impact on cross-border M&A activity and the optimal level of IPR protection in the post-TRIPS period is higher for developed targets than for emerging ones. Developed acquirers buy more emerging targets with higher IPR protection and emerging acquirers with higher IPR protection buy more developed targets. On the opposite, IPR protection for developed acquirers discourages them from cross-border M&A activity, the same happens when IPR protection improves in developed targets.

All the specifications in the above-mentioned models pass the tests for multicollinearity (checked by the Variance Inflation Factor). Some control variables, which were initially included in the models, are excluded as a result of these tests, for example, rule of law or control of corruption. However, even with multicollinearity, the results do not suffer much because all the significant variables retain their significance and about the same coefficients.

Heteroscedasticity is not expected in this kind of panel data models, but all the specifications are controlled for the heteroscedasticity and robust residuals are used.

The use of patent reforms in Ginarte and Park IPR index helps us to address endogeneity and omitted variable problems to the extent the reforms are adopted at the country level and are not endogenously influenced by any individual acquiring or target firm in the sample [10].

Table 4. Country-pair level analysis of IPR protection and cross-border M&A connection. Model (6): base case model for country pairs

Variables	Model (5): Em.tgt-Em.acq	Model (5): Dev. tgt-Dev.acq	Model (5): Dev. tgt-Em.acq	Model (5): Em.tgt-Dev.acq
	Log Bil. Deal Num.			
Patent Index Target	0.024	–0.058***	–0.037	0.054***
	(0.018)	(0.018)	(0.028)	(0.016)
Patent Index Acquirer	–0.010	–0.061***	0.085***	–0.054**
	(0.018)	(0.018)	(0.024)	(0.023)
GDP Per Capita Dif.	–0.001	–0.001	–0.002	0.001
	(0.001)	(0.001)	(0.001)	(0.001)
GDP Growth Dif.	–0.037	–0.310	–0.404	0.356***
	(0.111)	(0.177)	(0.179)	(0.119)
Market Return Dif.	–0.011	–0.056***	–0.018	–0.056***
	(0.016)	(0.021)	(0.016)	(0.014)

Variables	Model (5): Em.tgt-Em.acq	Model (5): Dev. tgt-Dev.acq	Model (5): Dev. tgt-Em.acq	Model (5): Em.tgt-Dev.acq
	Log Bil. Deal Num.			
Financial Mar. Dev. Dif.	–0.060**	–0.017***	0.001	–0.019
	(0.028)	(0.005)	(0.024)	(0.019)
Credit Mar. Dev. Dif.	0.042	0.001	0.007	–0.028
	(0.027)	(0.016)	(0.037)	(0.033)
Exchange Rate Dif.	0.018	0.198***	0.198***	0.375
	(0.048)	(0.007)	(0.015)	(0.721)
Distance	–0.020**	–0.078***	–0.081***	–0.074***
	(0.008)	(0.006)	(0.014)	(0.006)
Cultural Difference	–0.102	–0.273***	–0.816***	–0.274*
	(0.146)	(0.092)	(0.180)	(0.153)
Colonial Relationships	0.408***	0.125	0.270***	0.205***
	(0.158)	(0.098)	(0.105)	(0.075)
Common Law	0.076*	0.405***	0.012	0.032
	(0.045)	(0.051)	(0.063)	(0.038)
Common Religion	0.109**	0.078*	–0.020	0.055
	(0.053)	(0.041)	(0.077)	(0.042)
Common Language	0.089**	0.269***	0.571***	0.419***
	(0.044)	(0.065)	(0.121)	(0.094)
Constant	–0.0238	–1.098***	–0.286*	0.196
	(0.156)	(0.202)	(0.161)	(0.185)
Year FE	Yes	Yes	Yes	Yes
Target country FE	Yes	Yes	Yes	Yes
Acq. country FE	Yes	Yes	Yes	Yes
Country-pair FE	No	No	No	No
Observations	4864	17 600	5536	13 216
R-squared	0.6166	0.8211	0.7918	0.7487

Robust standard errors in parentheses; Significance *** p<0.01, ** p<0.05, * p<0.1.

Robustness checks

- For country-level models there are several ways to check the robustness of the influence of IPR protection on inbound cross-border M&A activity (Table 5, control variables coefficients are omitted):
- Summary statistics shows that the USA, Germany and the UK are the most active countries in terms of M&A, and the results can be driven by them, so the observations from these countries can be omitted *(Model (1R) and (1R-U)* [10; 16].
- M&A activity can be measured in terms of volume, rather than the number of deals *(Model (2R) and (2R-U)* [10; 11; 16; 18].
- The cross-border merger ratio can be used as a dependent variable instead of simple cross-border M&A, which is measured as the total number of cross-border M&A in a target country scaled by the sum of the domestic and cross-border deals at the country, country-pair and industry level [10; 11; 18]. In this case, the Tobit model should be used because the dependent variable is limited to the range between zero and one *(Model (3R) and (3R-U)*.

Table 5. Country-level analysis of IPR protection and cross-border M&A connection. Model (1R), (1R-U): base case regression without the three biggest countries; Model (2R), (2R-U): base case regression without deal volume; Model (3R), (3R-U): base case regression with cross-border merger ratio

Variables	Model (1R): Em.	Model (1R): Dev.	Model (2R): Em.	Model (2R): Dev.	Model (3R): Em.	Model (3R): Dev.
Patent Index	0.198***	0.245**	0.406*	0.622**	0.838*	5.311***
	(0.058)	(0.093)	(0.212)	(0.227)	(2.175)	(1.358)
Patent Index Squared						
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1056	896	1056	992	1056	992
R-squared	0.790	0.795	0.563	0.619		
	Model (1R-U): Em.	Model (1R-U): Dev.	Model (2R-U): Em.	Model (2R-U): Dev.	Model (3R-U): Em.	Model (3R-U): Dev.
Patent Index	0.711**	0.694*	2.331**	1.925**	16.58*	47.87***
	(0.333)	(0.431)	(1.099)	(0.863)	(10.36)	(12.18)
Patent Index Squared	–0.105**	–0.099*	–0.370**	–0.176*	–2.700*	–6.058***
	(0.047)	(0.062)	(0.166)	(0.134)	(1.741)	(1.665)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	759	644	759	713	759	713
R-squared	0.483	0.486	0.238	0.316		

Robust standard errors in parentheses; Significance *** p<0.01, ** p<0.05, * p<0.1.

Table 6. Country-pair level analysis of IPR protection and cross-border M&A connection. Model (4R): base case model for country pairs without the three biggest countries; Model (5R): base case regression without deal volume; Model (6R): base case regression with FE for country couples

Variables	Model (4R): Em.tgt-Em.acq	Model (4R): Dev.tgt-Dev.acq	Model (4R): Dev.tgt-Em.acq	Model (4R): Em.tgt-Dev.acq
		Log Bil. Deal Num.		
Patent Index Target	0.024	–0.021*	0.003	0.037**
	(0.018)	(0.016)	(0.025)	(0.016)
Patent Index Acquirer	–0.010	–0,000*	0.064**	–0.011*
	(0.018)	(0.019)	(0.025)	(0.020)
Year FE	Yes	Yes	Yes	Yes
Target country FE	Yes	Yes	Yes	Yes
Acq. country FE	Yes	Yes	Yes	Yes
Country-pair FE	No	No	No	No
Observations	4864	12 544	4480	10 496
R-squared	0.617	0.747	0.714	0.681
	Model (5R): Em.tgt-Em.acq	**Model (5R): Dev.tgt-Dev.acq**	**Model (5R): Dev.tgt-Em.acq**	**Model (5R): Em.tgt-Dev.acq**
Patent Index Target	0.020	–0.208***	–0.042	0.046*
	(0.051)	(0.042)	(0.077)	(0.041)
Patent Index Acquirer	–0.002	–0.197***	0.231***	–0.054*
	(0.048)	(0.053)	(0.058)	(0.054)
Year FE	Yes	Yes	Yes	Yes
Target country FE	Yes	Yes	Yes	Yes
Acq. country FE	Yes	Yes	Yes	Yes
Country-pair FE	No	No	No	No
Observations	4864	17 600	5536	13 216
R-squared	0.505	0.820	0.778	0.719
	Model (6R): Em.tgt-Em.acq	**Model (6R): Dev.tgt-Dev.acq**	**Model (6R): Dev.tgt-Em.acq**	**Model (6R): Em.tgt-Dev.acq**
Patent Index Target	0.024	–0.058***	–0.037	0.054***
	(0.018)	(0.018)	(0.028)	(0.016)
Patent Index Acquirer	–0.010	–0.061***	0.085***	–0.054**
	0.024	–0.058***	–0.037	0.054***
Year FE	Yes	Yes	Yes	Yes
Target country FE	No	No	No	No
Acq. country FE	No	No	No	No
Country-pair FE	Yes	Yes	Yes	Yes
Observations	4864	17 600	5536	13 216
R-squared	0.189	0.277	0.233	0.241

Robust standard errors in parentheses; Significance *** p<0.01, ** p<0.05, * p<0.1.

For the country-pair models (Table 6):

- As above, the three most active countries in terms of M&A as targets and acquirers can be excluded (*Model (4R)*.
- Again, M&A activity can be measured in terms of deal volume instead of number of deals *(Model 5R)* [10; 11; 14; 16; 18].
- Instead of using separate FE for target and acquirer countries, FE for country-pairs can be used *(Model 6R)*.

Many robustness check methods are implemented for both country level and country-pair level models. Generally, the conclusions from the empirical analysis are confirmed.

Conclusion

Intellectual property Rights protection has a serious impact on international investment decisions. The right choice of IPR protection level is an effective tool, which can significantly influence the countries' economies and stimulate the technology and knowledge transfer to developing countries through cross-border inbound M&A. It can result in the economic development of poor countries and help to partly solve one of the most serious issues in global economy of all times – the global inequality between countries.

The previous studies found the positive influence of IPR protection on cross-border inbound M&A activity in target countries. IPR protection has a higher influence on M&A activity in the industries, which are more intellectual capital-intensive and where IPR are more vital in production. This influence is stronger when the target country has weaker IPR protection than the acquirer country. Besides, the increase in the Patent Index of a target country is positively associated with synergy gains of cross-border M&A [1; 10].

This is one of the first research studies about the impact of IPR protection on international M&A activity, which is analyzed in detail for developed and emerging countries in the updated period until 2017 for the existence of positive and inversed U-shaped relationship.

Using the set of cross-border M&A in 64 developed and emerging countries from 1985 to 2017 it was discovered that better IPR protection in a target country attracts international M&A activity for the targets from emerging and developed markets. Besides, there is an optimal level of IPR protection in the target countries, which balances the costs and the benefits of IPR protection during the post-TRIPS period, and it is lower for emerging markets. Developed acquirers are more likely to buy emerging targets with higher IPR protection, and emerging acquirers with higher IPR protection are more likely to buy developed targets. Besides, cross-border M&A activity decreases for developed acquirers with improved IPR protection, and when developed acquirers buy developed targets with improved IPR protection. Besides, the Patent Index developed by Ginarte and Park is the best proxy for the IPR protection level so far.

There is a high potential for future research. First of all, the impact of IPR protection on M&A can be determined depending on the industry: IPR protection is expected to be more important in the technology-intensive and high-tech industries where the value of R&D is higher, and in the sectors with long life-cycles, where it is easier to steal a technology before it becomes obsolete. Secondly, the relationship between IPR and M&A should be determined in relation to different characteristics of target and acquirer companies, such as their age, size, assets, life cycle stage and others. Thirdly, the relationship between IPR and merger gains should be determined: it is expected that synergy gains in cross-border M&As are positively related to reforms of intellectual property rights. Fourth, the probability of cross-border M&A can be researched depending on IPR protection and other new factors, which were not commonly used before, for instance, the number of international trade agreements. Finally, since the membership in international patent agreements is the most significant component of the Patent Index, deeper research of impact on cross-border M&A seems promising.

Appendix 1

Control variables for country and country-pair level.

Variable	Sign	Description	Source
Log C-b Deal Number/ Volume	/	The logarithm of one plus the total number/volume of inbound cross-border M&A deals in a target country	Thomson Reuters
Log C-b Deals Number/Volume in pair	/	The logarithm of one plus the total number/volume of inbound cross-border M&A deals in a target country by an acquirer country	Thomson Reuters
C-b Deal Number/ Volume	/	The total number/volume of inbound cross-border M&A deals in a target country	Thomson Reuters
C-b Deals Number/Volume in pair	/	The total number/volume of inbound cross-border M&A deals in a target country by an acquirer country	Thomson Reuters
C-b Deal Number Share	/	The share of inbound cross-border M&A deals in a target country of the sum of these deals and domestic M&A deals	Thomson Reuters
Patent Index	+	PR index, which is obtained by the summation of extent of coverage, membership in international treaties, duration of protection, absence of restrictions on rights, and statutory enforcement provisions. Range: 0 to 5	Ginarte and Park, 1997; Park, 2008; e-mail from Park
IPR Index by Alliance	+	International Property Rights Index developed by the Property Rights Alliance	Property Rights Alliance
GDP per Capita	+	Logarithm of the real GDP per capita ($ mln)	World Bank
GDP growth	+	Average annual real growth rate of GDP (decimals)	World Bank
Trade Openness	+	Ratio of imports and exports to the real GDP (decimals)	World Bank
Market Return	–	Local stock market return (decimals)	World Bank
Financial Mar. Dev.	+	Total stock market capitalization divided by GDP (decimals)	World Bank
Credit Mar. Dev.	+	Total amount of private loans divided by GDP (decimals)	World Bank
Exchange Rate	+	National exchange rate scaled by dollar CPI (per $100)	World Bank
Log Dom. Deal Number/ Volume	+	The logarithm of one plus the total number/volume of domestic deals in a target country	Thomson Reuters
Dom. Deal Number/Volume	+	The total number/volume of domestic deals in a target country	Thomson Reuters
Dom. Deal Number Share	+	The share of domestic M&A deals in a target country of the sum of these deals and inbound cross-border M&A deals	Thomson Reuters
GDP per Capita Dif.	+	Average difference (AD) in the annual GDP per capita between target and acquirer countries ($ mln)	World Bank
GDP Growth Dif.	+	AD in the annual real GDP growth rate between target and acquirer countries (decimals)	World Bank

Variable	Sign	Description	Source
Market Rreturn Dif.	+	AD in the local stock market return between target and acquirer countries (decimals)	World Bank
Financial Mar. Dev. Dif.	+	AD in the total stock market capitalization divided by GDP between target and acquirer countries (decimals)	World Bank
Credit Mar. Dev. Dif.	+	AD in the total amount of private loans divided by GDP between target and acquirer countries (decimals)	World Bank
Exchange Rate Dif.	+	Average exchange rate of currency of target country per currency of acquirer country (per $100)	World Bank
Geographic Distance	–	The great circle distance between the capital cities of the countries, calculated with the usage of their latitudes and longitudes (k. km.)	CEPII
Cultural Difference	–	Difference in the citizens' answer to the question if most people can be trusted (decimals)	World Values Survey
Colonial relationships	+	Dummy variable, which is 1 if countries had a colonial relationship	CEPII
Variable	Sign	Description	Source
Common Law	+	Dummy variable, which is 1 if countries share the same legal origin	La Porta et al., 1998
Common Religion	+	Dummy variable, which is 1 if countries share the same religion, and 0 otherwise	CIA World Fact-book; Stulz&Wil-liamson, 2003
Common Language	+	Dummy variable, which is 1 if countries share the same primary language, and 0 otherwise	CEPII

Appendix 2

Country-level Patent Index and M&A activity from 1985 to 2017

Country	PI: 1985	PI: 2017	PI: average	# inbound c-b M&A	# outbound M&A	# domestic M&A	Av. GDP per capita (USD)	Dev./ Emer.
Argentina	1.54	4.02	2.95	993	165	841	7547	Emer.
Australia	2.49	4.88	4.09	4190	3126	13 785	32 007	Dev.
Austria	3.43	4.54	4.17	1116	1521	1108	33 010	Dev.
Belgium	4.09	4.22	4.48	2076	1905	1606	30 930	Dev.
Brazil	1.28	4.22	2.73	1964	359	3521	5767	Emer.
Bulgaria	0.00	4.42	3.11	368	65	346	3853	Emer.
Canada	3.16	4.42	4.18	6770	8829	18 197	30 942	Dev.
Chile	2.01	4.42	3.85	655	205	598	7355	Emer.
China	1.33	4.42	3.04	3264	1580	11 356	2522	Emer.
Colombia	0.96	4.42	2.83	489	184	345	3505	Emer.
Costa Rica	1.16	4.42	2.56	135	26	47	5273	Emer.
Cyprus	2.58	3.48	3.15	241	836	134	18 832	Dev.
Czech Republic	0.00	4.42	2.92	1002	240	1017	10 263	Dev.
Denmark	3.63	4.54	4.40	1947	1709	2497	40 466	Dev.
Ecuador	1.16	4.22	2.88	125	16	39	3105	Emer.
Egypt	1.41	4.02	2.37	203	57	176	1579	Emer.
Finland	3.31	4.88	4.31	1492	1655	3636	32 875	Dev.
France	3.76	4.42	4.41	6410	6546	15 823	29 400	Dev.
Germany	4.01	4.67	4.48	9137	6756	15 112	31 383	Dev.
Greece	2.33	3.88	3.79	231	272	626	16 427	Dev.
Hong Kong	2.70	4.02	3.43	1830	2783	2965	25 754	Dev.
Hungary	0.00	4.42	3.48	650	107	608	7468	Emer.
Iceland	1.67	3.42	2.98	38	199	84	37 478	Dev.
India	1.03	3.76	2.49	1351	1343	3569	756	Emer.
Indonesia	0.20	2.77	1.92	702	114	752	1591	Emer.
Ireland	2.03	4.33	3.92	1298	1826	1055	34 583	Dev.
Israel	2.78	3.96	3.52	622	641	467	21 824	Dev.
Italy	3.68	4.33	4.33	3391	1832	5995	25 856	Dev.
Japan	3.43	4.67	4.40	882	2773	17 596	34 607	Dev.
Kenya	1.58	3.22	2.72	84	37	51	649	Emer.
Lithuania	0.00	3.88	2.81	255	96	236	6418	Emer.
Luxembourg	2.57	3.76	3.68	414	1144	101	67 001	Dev.
Malaysia	1.92	3.23	2.93	805	1098	6167	5568	Emer.
Malta	1.40	3.23	2.64	61	70	25	13 937	Dev.

Country	PI: 1985	PI: 2017	PI: average	# inbound c-b M&A	# outbound M&A	# domestic M&A	Av. GDP per capita (USD)	Dev./ Emer.
Mauritius	1.73	2.57	2.17	70	110	19	5186	Emer.
Mexico	1.02	3.75	2.80	1305	414	907	6472	Emer.
Morocco	1.58	3.75	2.70	99	33	86	1883	Emer.
Netherlands	3.77	4.67	4.50	3753	4720	4642	34 110	Dev.
New Zealand	2.37	3.55	3.34	1228	500	1842	23 215	Dev.
Nigeria	2.37	2.89	2.70	83	27	136	985	Emer.
Norway	2.98	4.29	3.90	1746	1596	2834	53 701	Dev.
Panama	1.34	3.75	2.64	150	93	58	5945	Emer.
Peru	0.59	3.63	2.52	432	82	385	3050	Emer.
Philippines	2.36	3.88	3.28	272	124	629	1424	Emer.
Poland	0.00	4.00	3.05	1310	286	1819	6669	Emer.
Portugal	1.67	4.08	3.44	676	290	823	14 543	Dev.
Romania	0.00	4.00	3.07	619	37	294	4388	Emer.
Russia	1.41	3.80	3.11	1561	675	8189	5594	Emer.
Saudi Arabia	1.33	2.77	2.09	106	130	112	12 655	Emer.
Singapore	1.71	4.21	3.57	1368	2218	2094	29 676	Dev.
Slovakia	1.21	3.88	3.00	262	66	118	8887	Dev.
South Africa	2.90	3.88	3.52	907	646	2239	4408	Emer.
South Korea	2.49	3.93	3.91	601	587	3278	14 920	Dev.
Spain	2.64	4.33	3.94	3518	1854	7216	20 237	Dev.
Sweden	3.48	4.54	4.33	3111	4068	6077	37 976	Dev.
Switzerland	3.66	4.54	4.16	2298	3574	3186	52 858	Dev.
Thailand	1.21	3.23	2.35	389	189	846	3146	Emer.
Turkey	1.20	3.88	3.08	700	153	871	5986	Emer.
Ukraine	0.00	3.88	3.05	598	65	437	1762	Emer.
United Kingdom	3.88	4.54	4.45	13 404	14 239	38 878	30 575	Dev.
United States	4.68	4.88	4.83	19 207	28 079	173 634	37 768	Dev.
Uruguay	1.67	3.23	2.63	149	23	34	7582	Emer.
Venezuela	0.92	2.44	2.32	157	45	179	5288	Emer.

Appendix 3a

Summary statistics for the variables used in the country-level models

Variable	N	Mean	SD	P25	P50	P75
Deal Number	2112	55	109	3	17	55
Deal Volume ($ mln)	2112	5628	22 354	15	462	2979
Patent Index	2112	3.33	1.13	2.65	3.68	4.22
GDP Per Capita	2112	0.17	0.19	0.03	0.10	0.25
GDP Growth	2112	0.03	0.04	0.01	0.03	0.05
Trade Openess	2112	0.76	0.67	0.41	0.60	0.90
Market Return	2112	0.10	0.33	0.00	0.00	0.19
Financial Mar. Dev.	2112	0.49	0.96	0.00	0.25	0.66
Credit Mar. Dev.	2112	0.74	0.69	0.19	0.57	1.16
Exchange Rate	2112	4.13	21.16	0.01	0.04	0.31
Domestic Deals	2112	186	720	2	17	85

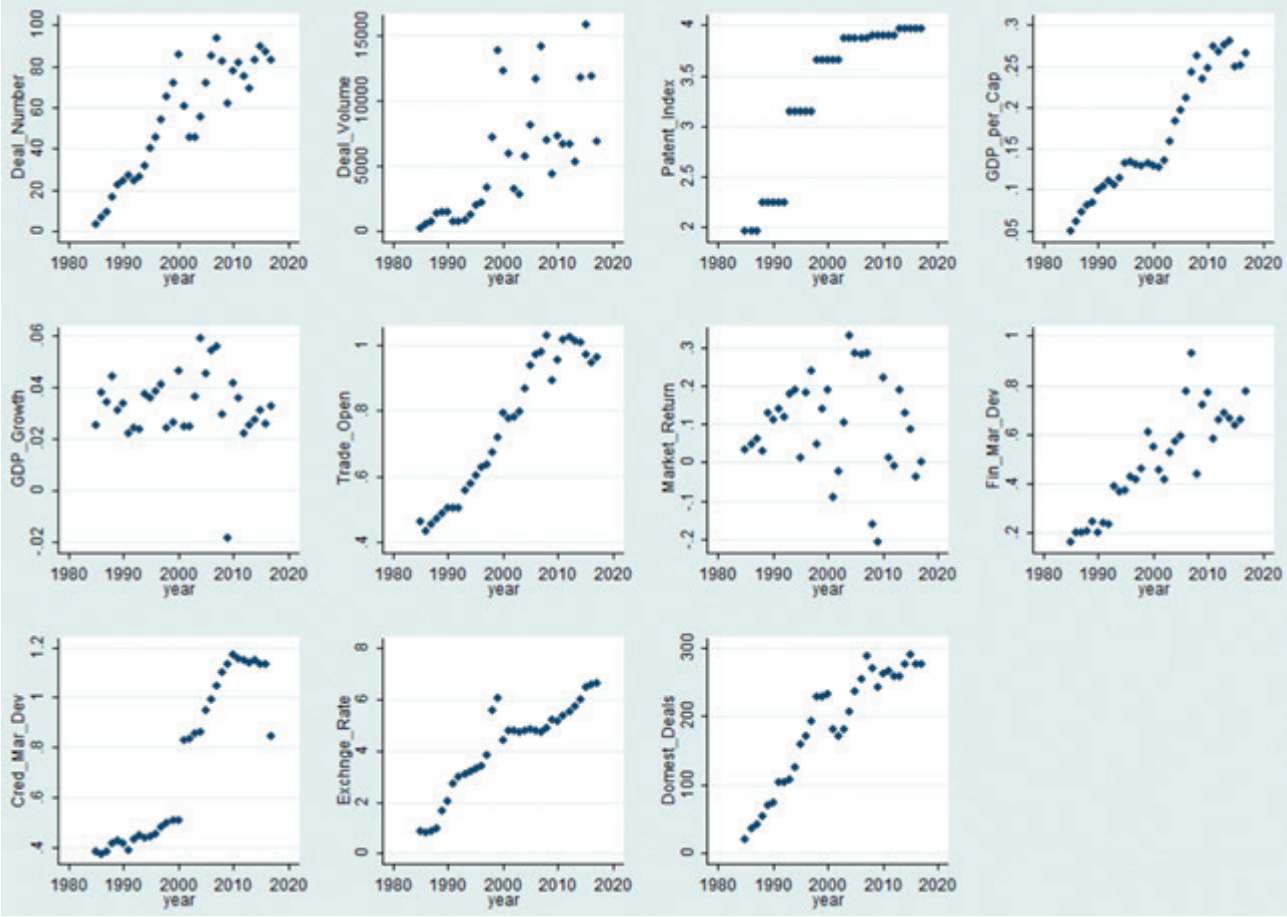
Appendix 3b

Summary statistics for the variables used in the country-pair models

Variable	N	Mean	SD	P25	P50	P75
Deal Number	42 504	3	12	0	0	2
Deal Volume ($ mln)	42 504	273	2551	0	0	4
Patent Index Target	42 504	3.58	1.20	3.00	4.00	4.00
Patent Index Acquirer	42 504	3.90	1.08	4.00	4.00	5.00
GDP Per Capita Dif.	42 504	–0.01	0.02	–0.02	0.00	0.01
GDP Growth Dif.	42 504	0.00	0.05	–0.02	0.00	0.03
Market Return Dif.	42 504	0.02	0.30	–0.05	0.00	0.07
Financial Mar. Dev. Dif.	42 504	–0.16	1.51	–0.64	–0.14	0.28
Credit Mar. Dev. Dif.	42 504	–0.15	0.68	–0.45	0.00	0.00
Exchange Rate Dif.	42 504	1.79	39.63	0.00	0.00	0.03
Distance	42 504	5.55	4.69	1.00	4.00	9.00
Culturl Difference	42 504	0.24	0.17	0.09	0.21	0.35
Colonial Relationships	42 504	0.06	0.25	0.00	0.00	0.00
Common Law	42 504	0.27	0.44	0.00	0.00	1.00
Common Religion	42 504	0.31	0.46	0.00	0.00	1.00
Common Language	42 504	0.18	0.39	0.00	0.00	0.00

Appendix 4

Dynamics of the model variables.



Appendix 5a

Correlation matrix for country-level models

Variable	Deal Number	Patent Index	GDP Per Cap.	GDP Gr.	Trade Open.	Mark. Ret.	Fin. Dev.	Cred. Dev.	Exch. Rate
Deal Number	1								
Patent Index	0.4424*	1							
GDP Per Cap.	0.4063*	0.5755*	1						
GDP Growth	–0.0653*	–0.0733*	–0.1442*	1					
Trade Openess	–0.0594*	0.1697*	0.2852*	0.1134*	1				
Market Return	–0,029	–0.0580*	–0.0862*	0.2555*	–0.0554*	1			
Fin. Mar. Dev.	0.1942*	0.2574*	0.2962*	0.0517*	0.4714*	–0.003	1		
Cred. Mar. Dev.	0.3384*	0.4035*	0.5145*	–0.0976*	0.2195*	–0.1096*	0.3146*	1	
Exchange Rate	–0.0665*	–0.0671*	–0.1421*	0.0994*	0,036	0,0043	–0.0584*	–0.0327	1
Dom. Deals	0.5185*	0.2779*	0.2528*	–0,0424	–0.1028*	–0,017	0.1378*	0.3109*	–0.0434*

Appendix 5b

Correlation matrix for country-pair models

Variable	Deal Numb.	PI Tgt.	PI Acq.	DGP Cap. Dif.	GDP Gr. Dif.	Mar. Ret. Dif.	Fin. Mar. Dif.	Cred. Mar. Dif.	Exch. Dif.	Distance	Cult. Dif.	Colony	Com. Law	Com. Rel.
Deal Numb.	1													
PI Tgt.	0.1644*	1												
PI Acq.	0.1526*	0.3122*	1											
GP Cap. Dif.	0.0100*	0.2048*	–0.3195*	1										
GDP Gr. Dif.	0.0146*	–0.0224*	0.1675*	–0.2255*	1									
Mar. Ret. Dif.	–0.0080	–0.0754*	0.0657*	–0.1235*	0.1772*	1								
Fin. Mar. Dif.	–0.0146*	0.0648*	–0.0580*	0.1795*	0.0341*	–0.0335*	1							
Cred. Mar. Dif.	–0.0075	0.1208*	–0.2324*	0.4506*	–0.2279*	–0.1367*	0.1874*	1						
Exch. Dif.	–0.0063	–0.0283*	–0.0198*	–0.0196*	0.0097*	0.0038	–0.0144*	–0.0261*	1					
Distance	–0.0535*	–0.0345*	0.0430*	–0.0366*	0.0203*	0.0271*	–0.0162*	–0.0726*	0.0181*	1				
Cult. Dif.	–0.0591*	0.0922*	0.1036*	–0.0244*	0.0170*	–0.0100*	0.0035	0.0131*	–0.0230*	-0.0328*	1			
Colony	0.1201	0.0263*	0.0093	0.0398*	0.0159*	0.0012	0.0142*	0.0184*	–0.0085	0.0274*	-0.1150*	1		
Com. Law	0.1028	–0.0170*	–0.0591*	0.0390*	0.0159*	–0.006	0.0243*	0.0342*	0.0008	0.0110*	-0.1298*	0.2106*	1	
Com. Rel.	0.0499*	0.0021	–0.0212*	0.0134*	0.0229*	–0.002	0.0127*	0.0316*	0.0058	-0.1321*	-0.0819*	0.0475	0.2255*	1
Com. Lang.	0.1419*	–0,0029	–0.0892*	0.0868*	0.0095*	–0.0201*	0.0322*	0.0632*	–0.0133*	0.0674*	-0.1005*	0.2946*	0.4524	0.1892*

References

1. Campi M., Dueñas M., Barigozzi M., Fagiolo G. Intellectual property rights, imitation, and development. The effect on cross-border mergers and acquisitions. *The Journal of International Trade & Economic Development.* 2019;28(2):230-256. https://doi.org/10.1080/09638199.2018.1518477
2. Branstetter L.G., Fisman R., Foley C.F. Do stronger intellectual property rights increase international technology transfer? Empirical evidence from U.S. firm-level panel data. *The Quarterly Journal of Economics.* 2006;121(1):321-349. https://doi.org/10.1093/qje/121.1.321
3. Allred B.B., Park W.G. Patent rights and innovative activity: Evidence from national and firm-level data. *Journal of International Business Studies.* 2007;38(6):878-900. https://doi.org/10.1057/palgrave.jibs.8400306
4. Fan J.P.H., Gillan S.L., Yu X. Innovation or imitation? The role of intellectual property rights protections. *Journal of Multinational Financial Management.* 2013;23(3):208-234. https://doi.org/10.1016/j.mulfin.2013.03.001
5. Ilie L. Intellectual property rights: An economic approach. *Procedia Economics and Finance.* 2014;16:548-552. https://doi.org/10.1016/S2212-5671(14)00837-5
6. Chaudhuri S., Goldberg P.K., Jia P. Estimating the effects of global patent protection in pharmaceuticals: A case study of quinolones in India. *The American Economic Review.* 2006;96(5):1477-1514. https://doi.org/10.1257/aer.96.5.1477
7. Stiglitz J.E. Economic foundations of intellectual property rights. *Duke Law Journal.* 2008; 57(6):1693-1724. https://doi.org/10.7916/D8474M9P
8. Bilir L.K. Patent laws, product life cycle lengths, and multinational activity. *The American Economic Review.* 2014;104(7):1979-2013. https://doi.org/10.1257/aer.104.7.1979
9. Dosi G., Stiglitz J. The role of intellectual property rights in the development process, with some lessons from developed countries: An introduction. LEM Working Paper Series. 2013;(23). https://doi.org/10.1093/acprof:oso/9780199660759.003.0001
10. Alimov A., Officer M.S. Intellectual property rights and cross-border mergers and acquisitions. *Journal of Corporate Finance.* 2017;45:360-377. https://doi.org/10.1016/j.jcorpfin.2017.05.015
11. Erel I., Liao R.C., Weisbach M.S. Determinants of cross-border mergers and acquisitions. *The Journal of Finance.* 2012;67(3):1045-1082. https://doi.org/10.1111/j.1540-6261.2012.01741.x
12. Shleifer A., Vishny R.W. Stock market driven acquisitions. *Journal of Financial Economics.* 2003;70(3):295-311. https://doi.org/10.1016/S0304-405X(03)00211-3
13. Rhodes-Kropf M., Robinson D.T., Viswanathan S. Valuation waves and merger activity: The empirical evidence. *Journal of Financial Economics.* 2005;77(3):561-603. https://doi.org/10.1016/j.jfineco.2004.06.015
14. Rossi S., Volpin P.F. Cross-country determinants of mergers and acquisitions. *Journal of Financial Economics.* 2004;74(2):277-304. https://doi.org/10.1016/j.jfineco.2003.10.001
15. Froot K.A., Stein J.C. Exchange rates and foreign direct investment: An imperfect capital markets approach. *The Quarterly Journal of Economics.* 1991;106(4):1191-1217. https://doi.org/10.2307/2937961
16. Ahern K.R., Daminelli D., Fracassi C. Lost in translation? The effect of cultural values on mergers around the world. *Journal of Financial Economics.* 2015;117(1):165-189. https://doi.org/10.1016/j.jfineco.2012.08.006
17. Hsu J., Tiao Y.-E. Patent rights protection and foreign direct investment in Asian countries. *Economic Modelling.* 2015;44:1-6. https://doi.org/10.1016/j.econmod.2014.08.018
18. Ferreira M.A., Massa M., Matos P. Shareholders at the gate? Institutional investors and cross-border mergers and acquisitions. *The Review of Financial Studies.* 2010;23(2):601-644. https://doi.org/10.1093/rfs/hhp070
19. Qian Y. Do national patent laws stimulate domestic innovation in a global patenting environment? A cross-country analysis of pharmaceutical patent protection, 1978-2002. *The Review of Economics and Statistics.* 2007;89(3):436-453. https://doi.org/10.1162/rest.89.3.436
20. Ginarte J.C., Park W.G. Determinants of patent rights: A cross-national study. *Research Policy.* 1997;26(3):283-301. https://doi.org/10.1016/S0048-7333(97)00022-X
21. Grossman G.M., Lai E.L.C. International protection of intellectual property. *The American Economic Review.* 2004;94(5):1635-1653. https://doi.org/10.1257/0002828043052312
22. Gallini N.T. Patent policy and costly imitation. *The RAND Journal of Economics.* 1992;23(1):52-63. https://doi.org/10.2307/2555432
23. Sweet C.M., Maggio D.S.E. Do stronger intellectual property rights increase innovation? *World Development.* 2015;66:665-677. https://doi.org/10.1016/j.worlddev.2014.08.025

24. Branstetter L., Fisman R., Foley C.F., Saggi K. Does intellectual property rights reform spur industrial development? *Journal of International Economics.* 2011;83(1):27-36. https://doi.org/10.1016/j.jinteco.2010.09.001

25. Rajan R.G., Zingales L. Financial dependence and growth. *The American Economic Review.* 1998;88(3):559-586. https://doi.org/10.3386/w5758

26. Klein M.A. Foreign direct investment and collective intellectual property protection in developing countries. *Journal of Economic Behavior & Organization.* 2018;149:389-412. https://doi.org/10.1016/j.jebo.2018.01.008

27. Javorcik B.S. The composition of foreign direct investment and protection of intellectual property rights: Evidence from transition economies. *European Economic Review.* 2004;48(1):39-62. https://doi.org/10.1016/S0014-2921(02)00257-X

28. Cook T.R., Liu A.H. Using linguistic networks to explain strength of intellectual property rights. *World Development*. 2016;87:128-138. https://doi.org/10.1016/j.worlddev.2016.06.008

29. Park W.G. International patent protection: 1960-2005. *Research Policy.* 2008;37(4):761-766. https://doi.org/10.1016/j.respol.2008.01.006

30. Stulz R.M., Williamson R. Culture, openness, and finance. *Journal of Financial Economics.* 2003;70(3):313-349. https://doi.org/10.1016/S0304-405X(03)00173-9

The article **was submitted** 11.01.2022; **approved after reviewing** 12.02.2021; **accepted for publication** 30.03.2022.

DOI: https://doi.org/10.17323/j.jcfr.2073-0438.16.1.2022.38-64
JEL classification: G30, D25, G11, G32

Do ESG Factors Influence Investment Attractiveness of the Public Companies?

Varvara Nazarova ✉
PhD in Economics, Researcher, Associate Professor,
National Research University Higher School of Economics, Saint Petersburg, Russia,
nvarvara@list.ru, ORCID

Victoria Lavrova
PJSC Gazpromneft, Chief Specialist of Investor Relations Department,
v_lavrova@inbox.ru, ORCID

Abstract

Even though there are numerous papers on the impact of ESG disclosure or performance on company performance, the topic remains disputable and controversial. The growing importance of ESG scores in investment decision-making has raised a question of whether the ESG score and its pillars influence the investment attractiveness of public companies. Using a sample of S&P 500 American and S&P 350 European companies in the period between 2010 and 2020, we examine the relationship between ESG performance and investment attractiveness, expressed by Tobin's Q, ROE, cost of capital and probability of paying dividends. We use the difference in means, panel regression and propensity score matching analysis and conclude that higher ESG performance positively influences Tobin's Q for both markets, while also providing evidence that ESG score transition to the above-median level may lead to a fairer valuation, higher probability of paying dividends and lower cost of capital, while return on equity is not subject to change. While previous research mainly focuses on one indicator, such as company value or cost of debt, this paper develops a set of investment attractiveness indicators and covers not only composite ESG performance, but also its environmental, social and governance pillars separately; it also emphasizes the influence on the industrial sector. Overall, our results suggest that managers pay close attention to ESG performance if it falls below median, although good ESG performance does not guarantee investment attractiveness.

Keywords: ESG scores, investment attractiveness, Tobin's Q, ROE, dividends, cost of capital

For citation: Nazarova, V., and Lavrova, V. Do ESG Factors Influence Investment Attractiveness of the Public Companies? *Journal of Corporate Finance Research.* 2022;16(1): 38-64. https://doi.org/10.17323/j.jcfr.2073-0438.16.1.2022.38-64

Introduction

ESG (Environmental, Social, Governance) is a set of indicators that allows evaluating companies and deciding whether these companies are sustainable enough to operate in the long run and to create value not only for shareholders, but also for society. Environmental factors mainly include companies' actions to prevent climate change by reducing greenhouse emissions, as well as by decreasing waste and increasing resource restoration. The social pillar comprises labour protection and safety and integration with local communities, ensuring the quality of products and supporting human rights and diversity. The governance pillar incorporates metrics associated with responsibilities and rights of companies' management, as well as balancing the interests of the management and the shareholders. Excellence in one pillar does not guarantee good performance in others; therefore, companies should pay attention to all these aspects to receive a good ESG composite score.

ESG issues play a major role in investment decision-making, moreover, it is a fiduciary duty, meaning that investors should integrate ESG factors into their investment analysis [1]. The majority of investors believe that ESG is highly relevant to investment performance and fully integrate ESG issues into their trading strategies [2]. Despite the fact that ESG is a broad term that includes different metrics (from carbon emissions to the number of women on the board of directors), more and more investors are sensitive to the ESG agenda. While USA investors tend to choose the inclusion strategy, which implies that they incorporate ESG factors into their investment analysis, rather than refuse to invest in specific companies or industries, many institutional investors in other countries are not allowed to invest in certain sectors, especially in industrial and energy companies, since high environmental exposure makes these companies toxic and risky in the wake of renewable energy development [3; 4].

The spread of ecological and other human-oriented initiatives convinced investors that in order to generate profits in the future, companies should be sustainable from the ecological, social and governance points of view. According to McKinsey [5], about a quarter of assets under management of the US investment institutes is related to companies with ESG scores. Results are similar for European institutions – according to Forbes, in 2018 ESG investing made up $20 trillion in assets under management in the world, which is around a quarter of total professionally managed assets [6]. Moreover, Bloomberg [7] reports that investments in ESG funds were three times higher in 2020 than in 2019. PwC [8] states that among 162 large firms, 91% have already adopted or are developing a responsible investment policy, while 72% are developing their own KPIs.

It is important to mention that not only investors, but also consumers, regulators and policymakers are interested in ESG development. But do ESG factors positively influence company value and investment attractiveness? This is the research question posed in this paper.

Not all researchers or company executives support the idea that ESG significantly influences company performance. Moreover, some believe that ESG creates value only in the long term, meaning that in the short term "anti-ESG" companies may be more profitable than ESG ones [9]. Motivated by the importance and relevance of ESG, the paper aims to examine the relationship between ESG performance and investment attractiveness of public companies, expressed by Tobin's Q, ROE, cost of capital and probability of paying dividends.

Even though there are papers that discuss the impact of ESG factors on financial performance, these papers mainly focus on one metric, while in this paper we attempt to develop a complex investment attractiveness indicator, which consists of several accounting and market performance metrics. Secondly, the majority of studies concentrate on the ESG composite score, while we also distinguish between its E, S and G components to conclude which specific pillar contributes more to the result and can affect performance. Moreover, quite a few articles differentiate between the industries, while in this study we believe that industrial companies may exhibit more pronounced effects. As for the empirical study, in order to exclude the potential influence of other events on companies' results and the possible causality problem, we employ propensity score matching models that allow separating companies with above-median and below-median ESG ratings and analysing the difference in performance, as well as judging whether a transition from a below-median ESG score to an above-median ESG score influences investment attractiveness. Finally, this paper relies on recent data from 2010 to 2020. The paper is similar to others in its attempt to reveal whether ESG indicators improve finance-related indicators and in using panel regression methodology. However, our research employs different measures of financial performance, uses more statistical methods for analysis, and concentrates on separate ESG pillars and industrial companies. These distinctions make the subject of research highly relevant.

Literature Review

ESG and companies' performance

It is a well-known fact that investors are interested in the future growth of company value, as higher prices brings returns on their investments. Most of the research concentrates on ESG disclosure or performance in relation to firm value, due to the belief that ESG can improve sustainability, which is the main driver of long-term value creation. Followed by this paradigm, a lot of authors examine whether ESG creates value for different companies in different countries and discover that in most cases this link is positive and significant [10–13]. Moreover, the link between company value and ESG might be substantial because consumers became more aware of sustainable practices and responsible consumption. If a company invests in ESG issues, the consumers are willing to buy its products, driving

the sales and net profit up. In turn, the assurance of seamless sales processes and adequate operating income, along with cost optimization ensures future growth and makes it easier to reliably forecast a company's cash flows, leading to a fairer valuation.

Secondly, ESG performance is believed to have a positive influence on company performance indicators, such as return on assets and equity, because responsible consumers require responsible company actions, and company sales demonstrate stable growth only if companies behave in a responsible manner. Higher sales and income, as well as cost reduction, employee motivation and asset optimization, in turn, can increase returns on equity and assets [5]. However, the results in this field can be controversial since ESG investing may be about being sustainable and profitable in the future, rather than about receiving higher returns now.

Risk reduction is another sphere in which ESG is usually thought to bring a positive impact. There are many papers stating that reporting on sustainability and ESG issues increases information transparency and reduces information asymmetry and associated risks. Risk reduction can bring benefits for companies, since many papers provide evidence that ESG disclosure leads to reductions in debt and equity costs [13–15]. Credit agencies and potential shareholders include ESG scores in their risk assessment models while assigning credit ratings affirmation or making lending decisions. For example, S&P Global considers ESG factors during business, financial and management risk assessment [16], while Moody's and Fitch also include ESG performance assessments in their reports to provide transparent information to its customers, who use the reports to assess risks and make investment decisions.

Finally, the relationship between dividends and ESG indicators is questionable. According to the Financial Times, the COVID-19 recession has shown that responsibility to staff and society nowadays outweighs dividend payments. During preceding market downsides, dividend payments were protected, as companies cut capital expenditures to ensure positive free cash flow. Today, however, the emphasis is placed on the society, employees, and their welfare [26]. Hence, some companies may lower or refuse to pay dividends to implement social projects.

ESG and Tobin's Q

A significant number of papers is related to ESG and company value. Usually, the authors hypothesize that ESG disclosure and performance positively affect company value, meaning that Tobin's Q increases. Li et al. [12] provide four reasons for the positive relationship between ESG disclosure and a company's value. First, ESG disclosure provides important information about financials, which improves price informativeness. Secondly, ESG disclosure strengthens the incentives for internal control, since ESG practices force to comply with regulations. Moreover, the availability of ESG information reduces information asymmetry between the company and related parties, strengthening the relationship with shareholders. Finally, many institutional managers assess company risks and use ESG factors. Thus, more transparent ESG information promotes better investment decisions. In addition, according to the stakeholder theory [10], ESG (especially social responsibility) concerns increase shareholders' wealth or company value, since concentrating on stakeholders' interests in some way guarantees that these stakeholders are interested in company's operations.

Many papers provided evidence that Tobin's Q increases in response to ESG. For example, Fatemi et al. [11] find that strong ESG indicators increase company value. The authors considered both ESG performance and ESG disclosure (the dummy variable that indicates whether a company discloses ESG metrics). They also found that ESG disclosure itself does not affect valuation, thus, it is important not only to disclose information, but also to succeed in being ESG-oriented. Li et al. [12], who similarly conclude that higher CEO power strengthens the influence of ESG disclosure on firm value, also support this idea. On the other hand, Wong et al. [13] doubt that disclosure influences firm value, while the score does not. Thus, the results differ between countries and different types of markets. In developed markets, investors are ready to pay attention to the scores, while in developing markets the mere fact of disclosure can be sufficient.

Bardos et al. [10] examine how CSR can affect company value. The authors find that there is an indirect relationship between CSR and company value, as CSR influences market perception, which in turn increases market value. Rjiba et al. [18] also find that corporate financial performance, measured by Tobin's Q, is positively affected by corporate social responsibility, and this connection is more pronounced during periods of high economic uncertainty.

There was also research discussing how ESG controversies affect firm value and corporate performance [19], where the authors found that negative events in the ESG sphere can significantly and negatively affect Tobin's Q.

ESG and financial performance

Investment in ESG can reduce risks associated with a company's sustainability and information asymmetry, which in turn can drive profits up [20]. A lot of studies have been dedicated to exploring the relationship between ESG or CSR concepts and financial results.

Alonso-Almeida et al. [21], who study the influence of quality management systems on hotel business, note that there is a strong and positive relationship between social responsibility and financial results for industrial companies in Mexico, measured by return on assets, return on equity, price to book ratio and earnings per share.

On the other hand, evidence from Germany [22] shows that the governance component positively and significantly affects return on assets and Tobin's Q, while environmental and social components are less significant. These results are explained by the fact that corporate governance in Germany has been reported for a long time.

Alareeni and Hamdan [23] offer complex research and investigate the influence of ESG composite score and E, S

and G components separately on financial performance, measured as ROE, ROA, and Tobin's Q. The overall results state that a composite ESG score positively affects all these metrics, while environmental and social components negatively influence ROE and ROA, which is explained by the fact that company profits may decrease due to higher ESG spending, while the positive influence on Tobin's Q is associated with a positive market perception of ESG investments. Ortas et al. [24] agree that environmental and social pillars have a significant influence on Tobin's Q, but the authors doubt that influence on ROA is positive as well. Landi and Sciarelli [25] study whether socially responsible investors can outperform the market and gain excess profits, discovering no significant impact of ESG on stock returns. Thus, there are some more controversial results, and the topic remains interesting.

Zhou et al. [26] believe that return on capital employed is also a good measure of financial performance, and the authors conclude that ESG factors have a positive influence on ROCE, implying that Chinese power generation companies should pay more attention to ESG, albeit their sample is too small.

According to Benlemlih [27], corporate social responsibility can affect dividend payments from different points of view. First, dividend policy can serve as a disciplinary mechanism and prevent a company from overinvestment (including ESG areas). Hence, higher investment in CSR should be associated with lower dividend payments. On the other hand, Samet and Jarboui [28] provide evidence that higher CSR investments do not usually reduce dividends for shareholders. Moreover, CSR investment leads to increased profits through lower risks and better shareholder relations, which ensures higher dividends [20]. However, the authors also think this question is controversial since CSR activities may reduce the cost of capital and lead to more investment rather than dividend payouts.

The key conclusions from the literature review are presented in Table 1.

Table 1. Literature review summary on ESG and investment attractiveness

	Positive impact	Negative impact	No impact
Firm value	Environmental, social, and corporate governance components positively affect Tobin's Q [23]	Negative events in ESG area can significantly and negatively affect Tobin's Q [19]	No significant influence of ESG on Tobin's Q [22]
	Positive relationship between social pillar and Tobin's Q [24; 18]		Only ESG disclosure (not score) affects valuation [13]
	Positive ESG score influence on firm value [11; 12]		Indirect relationship between CSR and firm value [10]
Financial performance	Significant and positive relationship between CSR and ROE, ROA, EPS, P/B [21]	ESG does not provide excess returns on stocks [25]	The influence of ESG on financial performance (P/B, ROE, ROA, ROI) is not significant [8]
	Corporate governance is positively associated with ROA [23]	Environmental and social components negatively affect ROA and ROE, while corporate governance negatively influences ROE [23]	
	ESG positively influences ROA, G has the most significant effect [22]		
	The impact of ESG factors on ROCE in power-generating Chinese companies is positive [26]		
	Positive relation between social and environmental pillar and ROA [24]		

	Positive impact	Negative impact	No impact
Cost of capital		Negative relationship between cost of equity and CSR [14]	ESG certification lowers cost of capital; ESG performance does not[13]
		Lower cost of debt with ESG disclosure [15]	
Dividends	Higher CSR does not usually reduce dividends [28]		No significant influence of ESG on dividend payments [30]
	CSR investment leads to profit increase and higher dividends [20]		
	Higher CSR increases dividends [27]		

Considering that the above-mentioned indicators can be closely connected with investment attractiveness and may be affected by ESG performance, we propose our first hypothesis.

H1. Better ESG performance has a positive influence on investment attractiveness indicators, measured by Tobin's Q, return on equity, cost of capital and probability of paying dividends.

ESG indicators in different industries

In this paper, we assume that the effect of ESG performance on investment attractiveness indicators may be more pronounced for the industrial companies (including industrial, energy and materials sectors) due to several reasons. First, in 2018, 985 investors from 37 countries have already declined to invest in oil companies, which left the industry with $6.25 trillion less in assets; this number is growing by 25% annually [3]. Another example of industrial companies' incentives to improve ESG (especially environmental concerns) is the fact that the World Bank has announced that it would no longer invest in oil and gas starting in 2019 [4]. Thus, we suppose that industrial companies, being more exposed to risks associated with environmental damage, tough working conditions and further underinvestment, are expected to invest more in ESG and receive a more pronounced response from the investment community, which means better investment attractiveness.

For example, Taliento et al. [29] find that ESG is different across industries, and when ESG exceeds the industry average, it can significantly and positively influence financial performance. While studying the UN Global Compact participants' results and ESG, Ortas et al. [24] found that the positive relationship is more pronounced for companies in the energy and healthcare industries. Alonso-Almeida et al. [21] note the strong and positive relationship between social responsibility and financial results industrial companies. The summary of the key prior studies' results is presented in Table 2.

Table 2. Literature review summary on ESG and industries

	Positive impact	Negative impact	No impact
ESG in industries	ESG affects financial ratios in different industries [29]		ESG mostly affects financial ratios in industrial companies, but not significantly [31]
	Energy and healthcare sectors show higher ESG impact on performance [24]		
	Industrial companies have strong ESG influence on results [21]		

Accordingly, we postulate our second hypothesis:

H2. The impact of ESG performance on investment attractiveness is stronger for industrial companies.

To sum up, it is important to note that the knowledge base in regard to the relationship between ESG concepts and financial or market performance is developing. Most studies find a positive link between ESG disclosure and market performance, mainly measured by Tobin's Q. Moreover, ESG can positively influence ROE and ROA, as well as lower cost of capital and increase the probability of paying dividends. There was also evidence that some ESG pillars can have a greater influence in some industries. Thus, we would like to expand the existing knowledge in this sphere and consider different types of financial performance indicators: accounting (ROE), market (Tobin's Q), investment (cost of capital) and corporate governance (dividend payments), contributing to the creation of a more comprehensive picture of investment attractiveness.

Research Design

Data

As ESG topics are usually more relevant for big public companies, we are analysing the companies included in the S&P 500 index in 2010–2020. The S&P 500 index consists of 500 public companies traded on the US stock market with the largest capitalization, and includes 11 sectors: Communication services, Consumer discretionary, Consumer staples, Energy, Finance, Health care, Industrials, Information technology, Materials, Real estate, and Utilities. However, we excluded the financial sector from our analysis, as the metrics used to assess the performance of financial companies are different from the metrics we have selected. Our choice of the S&P 500 index allows taking into consideration different industries and at least a 10-year period of ESG performance reporting. Moreover, this index covers approximately 80% of the US equity market capitalization, which is why the results of this study can be extrapolated to the general population. We also compare our results with the results received for the European market by performing the same analysis on the S&P 350 index of European companies with the largest capitalization. This analysis will allow us to suggest that influence of ESG scores on investment attractiveness may be different in the US and European markets. To minimize the influence of outliers on the results, we use winsorization at a 1% level. Due to the missing data, the number of S&P 500 companies was decreased to an average of 250, while S&P350 comprises an average of 177 companies. Table 3 shows the number of companies in our sample for each year, as well as their industry distribution.

The data is noticeably unbalanced, and 2020 contains the least observations, since not every company has reported its results yet. Moreover, industrial companies make up 20% of all observations, followed by health care and consumer discretionary sectors.

Table 3. Distribution of observations by year and industry

Year	S&P 500 Obs.	S&P 350 Obs.	Industry	S&P 500 Obs.	S&P 350 Obs.
2010	242	168	Communication Services	55	157
2011	255	171	Consumer Discretionary	369	227
2012	260	171	Consumer Staples	243	193
2013	250	171	Energy	180	60
2014	255	175	Health care	424	217
2015	259	175	Industrials	551	502
2016	249	180	Information Technology	196	113
2017	250	184	Materials	257	318
2018	259	187	Real estate	228	52
2019	256	187	Utilities	264	111
2020	232	181			

We retrieve financial and ESG data from the Thomson Reuters database yearly in 2010–2020.

Dependent variables

We designed different models for four dependent variables. The first measure of investment attractiveness is Tobin's Q, calculated as the market value of equity plus the book value of debt over total assets. Tobin's Q is used as a proxy for firm value in many papers [10; 12; 13; 18; 19; 32; 33]. Thus, we also use this proxy for firm value and investment attractiveness indicator.

The second variable is return on equity (ROE), defined as net income to total equity ratio, measuring company's accounting performance.

Moreover, we will also estimate the probability of paying dividends, measured by a binary variable – 1 if a company pays dividends, 0 otherwise [30]. Some authors [27] concentrate on dividend payout rather than probability. However, in this paper, we focus on the probability of payments, since this indicator is more appropriate for investors in regard to investments in different industries.

Finally, we also think that the cost of capital may be a measure of investment attractiveness. Dhaliwal et al. [14] state that there is no "best" proxy for the cost of capital, using the average of the three metrics proposed in the previous research. Wong et al. [13] used the standard WACC calculation as the cost of capital indicator while estimating the cost of equity through the CAPM model. As the calculation of the cost of capital is not the objective of this paper, we will use the weighted average cost of capital, calculated in the Thomson Reuters database.

Independent variables

As for the independent variables, we began with the main variable of interest – ESG score. Different agencies provide ESG scores using different methodologies. For example, MSCI ESG research uses 35 key indicators selected annually for each industry and weighted to combine the overall ESG rating and pillars [1]. Bloomberg, one of the main financial providers, also covers ESG data, but mostly concentrates on ESG disclosure and industry-specific scores. An independent global provider of ESG research to investors, Sustainanalytics, offers ESG risk scores based on 300 indicators [34]. There are many more other agencies and ratings, but to ensure that financial and ESG data are available for the same sets of companies and to avoid measurement errors, we would like to use the Thomson Reuters ESG score. The score considers 178 ESG indicators for each company, grouped by 10 categories: resource use, emissions, innovation, management, shareholders, CSR strategy, workforce, human rights, community and product responsibility. These categories are grouped and weighted to generate the ESG score. Some of the categories have larger weights in the total score. For example, management (34 indicators) is the principal marker for governance, while workforce (29 indicators) is the most valuable in social pillar, and emissions (22 indicators) is of primary importance in the environmental category. The data is based on company reports and news with independent audits and management review. S&P500 companies have been included in this ESG score database since 2003. Moreover, we would also like to analyse the influence of separate environmental, social and governance scores (pillars) on investment attractiveness. Since Thomson Reuters also provides scores by pillars, we included them in our models. It is also important to highlight that these scores measure companies' ESG performance, rather than just disclosure. Many researchers rely on these scores while studying ESG concerns [15; 19; 30; 35]. The score scale ranges from 0 to 100, where 100 is a maximum score.

Control variables

To ensure that the results are robust, control variables are included. We use different sets of control variables for each dependent variable; a pivot table can be found in Table 4. Since the influence of ESG on investment attractiveness may have become more intense since 2015, when the Paris agreement was adopted to limit global warming through economic and social transformation and involving all the countries and companies in that process, we include a dummy variable 2015, which allows to analyse whether the ESG performance after 2015 affects investment attractiveness more than before.

Table 4. Model components

Dependent	Tobin's Q	ROE	Cost of capital	Dividend payment
Independent variables	ESG score	ESG score	ESG score	ESG score
	E (environmental score)	E (environmental score)	E (environmental score)	E (environmental score)
	S (social score)	S (social score)	S (social score)	S (social score)
	G (governance score)	G (governance score)	G (governance score)	G (governance score)
Control variables	Size = ln(total assets)	Size = ln(total assets)	Size = ln(total assets)	Size = ln(total assets)
	Leverage = total debt/total assets	Leverage = total debt/total assets	Leverage = total debt/total assets	Capex/total assets
		Asset turnover = sales/total assets	ROA	ROA
	Liquidity = current assets/current liabilities	Profit margin = net profit/sales	Interest coverage ratio = operating income/interest paid	Leverage = total debt/total assets
	Growth = ln(Sales_t-1/Sales_t-2)	Life cycle = retained earnings/equity	Beta	Growth = ln(Sales_t-1/Sales_t-2)
	ROA	2015 (dummy variable, 1 – after 2015, 0 – otherwise)	Dividend payout (dividends/earnings)	Market-to-book ratio
	Capex/total assets		Capex/total assets	Life cycle = retained earnings/equity
	Dividend payout (dividends/earnings)		2015 (dummy variable, 1 – after 2015, 0 – otherwise)	Liquidity = current assets/current liabilities
	2015 (dummy variable, 1 – after 2015, 0 – otherwise)			Cash from operating activities/total assets
				2015 (dummy variable, 1 – after 2015, 0 – otherwise)

Difference in means analysis

Before carrying out econometric modelling, we performed the statistical tests that compare the means of the variables of interest within the two groups.

First, the sample was divided into companies with above-median ESG score and companies with lower than median ESG scores. T-test for differences in means was carried out to analyse whether the differences of means in investment attractiveness factors and firm characteristics between the two groups are significant. Moreover, we carried out this analysis for each industry.

We are also interested not only in how indicators in companies with or without ESG scores are different, but also in whether ESG scores (as well as E, S and G pillars) are different across industries, for which we used a multivariate test.

Panel regression analysis

Next, regression analysis was carried out. As there are a lot of models (different investments attractiveness measures), the common model forms are as follows:

$$DepVar_{it} = \alpha_0 + \alpha_1 ESG_{it-1} + \beta Control_{it-1} + \varepsilon_{it}, \quad (1)$$

$$DepVar_{it} = \alpha_0 + \alpha_1 E_{it-1} + \alpha_2 S_{it-1} + \\ + \alpha_3 G_{it-1} + \beta Control_{it-1} + \varepsilon_{it}, \quad (2)$$

$$DepVar_{it} = \alpha_0 + \alpha_1 ESG_{it-1} + \\ + \alpha_2 ESG_{it-1} * industrial + \beta Control_{it-1} + \varepsilon_{it}, \quad (3)$$

where DepVar are Tobin's Q, ROE, cost of capital, probability of paying dividends. ESG – ESG score for the overall model. E, S and G in equation 2 are the separate ESG pillars. Control variables are size, leverage, liquidity, capex, and others presented in Appendix 1, as well as time effects, and $\varepsilon_{it,}$ – error term. 'Industrial' in the third model is a dummy variable that equals 1 if a company is from the energy, industrial or materials industries, 0 – otherwise.

It is important to note that dividend payout probability is estimated by the logistic regression that models a binary dependent variable by using a logistic function.

To mitigate potential endogeneity problems caused by the simultaneity of dependent and independent variables, independent variables (ESG and control variables) are taken as lag values. There is also a logical reason for using lag values from the financial point of view: assets, equity and capex of the current year are unlikely to have any influence on the results of this year – these numbers will have more influence on the following year's results. In addition, investors first review ESG scores and sustainability reports and only make their investment decisions later on. Moreover, it also makes sense for new investors who examine previous reports and data before investing.

Pooled OLS, fixed effects and random effects models are applied. According to previous research, the fixed effect model was the most popular in estimating the relationship between financial data and ESG scores [12; 13; 15]. The best specification for each model is determined by using Breusch-Pagan and Hausman tests. A cluster-robust variance estimator allows to capture the potential problem of heteroscedasticity, while a correlation matrix allows to avoid multicollinearity. We use RESET-tests for panel data to ensure that there is no endogeneity caused by omitted variable bias. Our research design in the panel regression analysis differs from other research in its attempt to find a cross-effect relationship to confirm the second hypothesis about industrial companies (model 3).

Propensity score matching modelling

Come to think about ESG as a policy that companies incorporate in their strategies and operations nowadays, it is also interesting to estimate the treatment effect of the ESG score. Thus, we are interested in whether the investment attractiveness of companies with above-median ESG score (treatment group) is different from the companies with below-median ESG scores (control group). It might seem that this question has been already put forward while performing the difference in means analysis. However, there are some factors that can affect receiving an ESG score – for example, larger companies may have ESG scores just because they are large and well-known, which leads to selection bias.

As the problem of selection bias may appear, it can be useful to implement propensity score matching that assigns the sample to control and treatment groups regardless of their characteristics. A propensity score is a probability that a company with certain characteristics will be assigned to the group where the companies have above-median ESG scores (as opposed to the control group). The selection bias is eliminated by balancing covariates (the characteristics of participants) between treatment and control groups [36]. The advantage of this approach is that this is a non-parametric method, which does not require to develop functional dependencies.

There are six steps in propensity score matching. First, following Shipman et al. [37] and Rjiba et al. [18], we assigned scores to treatment and control groups. Since there are quite a few companies with a zero ESG score, we assume that observations with an ESG score lower than the sample median are assigned to the control group, while those with an ESG score higher than the sample median – to the treatment group. Secondly, covariates should be selected (the variables that can be included in the logit model to predict the probability of receiving a treatment effect). In this paper, covariates are selected specifically for each model and explained in the control variables' description. Afterwards, propensity scores (probabilities of treatment) are calculated. Despite the existence of various methods, we implemented logistic regression due to its widespread use. Hence, in the second step, we calculated the probability that a firm will have above-median ESG scores based on its characteristics.

After propensity scores are calculated, the control and treatment groups are matched based on similar characteristics. There are several ways to match the groups: nearest neighbor, exact matching, optimal matching, and some others. Exact matching requires certain categorical data such as age or gender, which is why it is not best-suited for

our study, since exact financial indicators rarely exist. Following prior research, we use the nearest neighbor method for matching within a caliper distance of 0.001, since it searches for the closest nearest value rather than for an exact match [18]. After creating the matches, a quality assessment is provided to ensure that participants and non-participants are balanced. Finally, the treatment effect can be evaluated by calculating the differences between treatment and control groups. Our propensity score model does not differ from the models in the previous research, but it should be noted that very few papers implement treatment effects to evaluate the influence of the ESG scores, therefore our paper differs from others in the research design.

Results

Descriptive analysis

We begin our analysis with summary statistics (Table 5). It is apparent that the companies in this sample are typically overvalued since their Tobin's Qs are more than 1. Moreover, the companies show relatively high returns on equity, while cost of capital is moderate and the majority of companies pay dividends.

As for the ESG indicators, none of the companies have the highest 100-degree score. The average score in US companies is around 55, which equals a B- on the scale from A+ to D-. Thus, this score is in the middle and we cannot claim that S&P500 companies on average show excellent ESG performance. Governance shows the highest average pillar score, which may imply that the idea of governance improvement was popular a long time ago, and by now, companies are demonstrating above-average governance practices. The poorest-scoring average pillar is environmental, meaning that on average companies have a below-median environmental score that requires improvement.

On the other hand, the European S&P 350 companies on average show better ESG performance at around 68, which equals a B+. This result is mainly achieved by a stronger social pillar, followed by environmental. Unlike S&P 500 companies, S&P 350 companies show the lowest score in the governance pillar, which can be explained by the fact that the USA and Europe have different governance models.

Table 5. Summary statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Dependent variables					
S&P 500					
Tobin's Q	2,767	3.47	3.74	0.52	23.74
ROE	2,767	24.15	24.00	2.48	162.89
Cost of capital	2,767	6.39	3.49	2.35	23.01
Dividends	2,767	0.91	0.29	0.00	1.00
S&P 350					
Tobin's Q	2,108	3.43	4.79	0.42	31.12
ROE	2,108	19.94	14.20	2.23	82.27
Cost of capital	2,108	7.06	2.97	1.22	18.32
Dividends	2,108	0.94	0.24	0	1
Explanatory variables					
S&P 500					
ESG score	2,767	54.09	21.36	0.00	88.38
E pillar	2,767	48.92	28.27	0.00	91.97
S pillar	2,767	55.61	23.59	0.00	94.92
G pillar	2,767	56.69	23.65	0.00	93.87
S&P 350					

Variable	Obs	Mean	Std. Dev.	Min	Max
ESG score	2,084	67.96	15.54	22.24	92.77
E pillar	2,084	67.70	20.78	6.42	96.79
S pillar	2,084	71.18	18.41	18.50	96.52
G pillar	2,084	62.62	20.41	11.24	95.48
Control variables					
S&P 350					
Size	2,108	23.47	1.32	18.50	27.13
Leverage	2,108	0.25	0.13	0.01	0.58
ROA	2,023	7.40	5.20	0.78	32.00
Liquidity	2,108	1.39	0.61	0.42	3.73
Capex	2,078	0.04	0.03	0.00	0.15
Growth	1,867	0.03	0.17	–1.57	2.28
Dividend payout	2,108	61.75	220.09	–1754	4350
Profit margin	2,096	11.59	15.89	0.33	127.42
Asset turnover	2,051	0.80	0.45	0.05	2.46
Interest coverage	2,108	30.45	84.14	0.44	631.30
Beta	2,108	0.97	0.44	0.06	2.14
Market-to-book	2,108	7.86	10.27	0.47	57.43
Cash from OA	2,107	0.10	0.06	0.01	0.34
Life cycle	2,079	0.79	0.32	0.04	1.74
2015	2,108	0.44	0.50	0	1
S&P 500					
Size	2,767	23.50	1.18	19.39	27.38
Leverage	2,767	0.29	0.15	0.00	0.67
ROA	2,767	7.14	3.57	2.57	13.42
Liquidity	2,767	1.42	0.90	0.00	4.41
Capex	2,767	0.04	0.03	0.00	0.17
Growth	2,767	0.14	0.34	–2.17	2.49
Dividend payout	2,767	38.82	59.10	–104.85	341.02
Profit margin	2,767	10.85	9.60	–8.87	50.98
Asset turnover	2,767	0.80	0.68	0.00	3.56
Interest coverage	2,767	16.61	38.95	–2.07	302.50

Variable	Obs	Mean	Std. Dev.	Min	Max
Beta	2,767	0.62	0.42	0.00	1.84
Market-to-book	2,767	10.37	14.13	0.49	90.91
Cash from OA	2,767	0.10	0.05	–0.02	0.27
Life cycle	2,767	1.02	1.32	0.20	8.44
2015	2,767	0.45	0.98	0.00	1.00

Difference in means analysis

First, we divided our sample into the group with above-median ESG, E, S and G scores, and the group with below-median scores. By doing so, we suggest that companies with above-median ESG (and E, S, G pillars) have significantly better investment attractiveness indicators.

After the sample was divided into the companies with above-median ESG scores and the companies with below-median scores, we examined the differences between the means of the dependent and control variables (Table 6 and Table 7). First, Tobin's Q of the companies with higher ESG scores is significantly smaller for both American and European companies, meaning that these companies are relatively undervalued and potentially reflecting the future growth potential of undervalued companies, which is good for investors. This result is robust for every pillar. As for the return on equity, there is also strong evidence that firms with above-median ESG and pillar scores reveal higher returns on equity, which is a measure of higher efficiency. There is also a significant difference in the cost of capital, and companies with higher ESG scores have lower costs of capital, which is in line with our assumptions and reveals lower risks. As for the dividends, there is a significant difference in probability of payment, and companies with higher ESG scores are more likely to pay dividends.

It can be also claimed that companies with better ESG performance have greater assets and are more leveraged. Moreover, they report higher capital expenditures, have sufficient retained earnings and a lower market-to-book ratio - a sign of undervaluation. American companies with above-median ESG scores also exhibit higher return on assets, asset turnover, and more cash from operating activities and interest coverage ratio, while European companies demonstrate the opposite dynamics. On the other hand, these companies are riskier as they have higher betas. There is no significant difference in the means of growth, dividend payout or profit margin.

Table 6. Difference in means analysis for S&P 500 companies

	ESG score *Above median*	*E score* *Above median*	*S score* *Above median*	*G score* *Above median*
Tobin's Q	<***	<***	<***	<***
ROE	>***	>***	>***	>***
Cost of capital	<***	<***	<***	<***
Dividends	>***	>***	>***	>***
Size	>***	>***	>***	>***
Leverage	>***	>***	>*	>***
ROA	>***	>*	>***	<***
Liquidity	<***	<***	<***	<***
Capex	>***	>***	>***	>***
Growth	–	–	<**	<**
Dividend payout	–	–	–	–
Profit margin	–	–	>*	–

	ESG score *Above median*	*E score* *Above median*	*S score* *Above median*	*G score* *Above median*
Asset turnover	>***	>*	>**	–
Interest coverage	>*	–	>***	–
Beta	>**	–	>**	>***
Market-to-book	<***	<***	<***	<***
Cash from OA	>**	>***	>***	–
Life cycle	>***	>***	>***	>***

The table presents the results of the difference in means analysis. > denotes the fact that the indicator is higher for companies with above-median ESG performance. < denotes the fact that the indicator is lower for companies with above-median ESG performance. * denotes p < 0.10; ** denotes p < 0.05; and *** denotes p < 0.01.

Table 7. Difference in means analysis for S&P 350 European companies

	ESG score *Above median*	**E score** *Above median*	**S score** *Above median*	*G score* *Above median*
Tobin's Q	<***	<***	<***	<***
ROE	<***	<***	–	<***
Cost of capital	<***	<***	<**	<**
Dividends	>***	>***	>***	–
Size	>***	>***	>***	>***
Leverage	>***	>***	–	>***
ROA	<***	<***	–	<***
Liquidity	<***	<*	–	–
Capex	>***	>***	>***	>**
Growth	<***	<***	<***	<**
Dividend payout	>***	>***	>**	>***
Profit margin	<***	<***	–	<**
Asset turnover	<**	–	–	<**
Interest coverage	<***	<***	–	<***
Beta	>***	>**	–	>**
Market-to-book	<***	<***	<***	<***
Cash from OA	<***	<***	–	<**
Life cycle	>**	–	>***	>***

The table presents the results of the difference in means analysis. > denotes the fact that the indicator is higher for companies with above-median ESG performance. < denotes the fact that the indicator is lower for companies with above-median ESG performance. * denotes p < 0.10; ** denotes p < 0.05; and *** denotes p < 0.01.

Since firm characteristics and control variables are not the main variables of interest, we shortened our industry-based analysis and examined whether there are differences in investment attractiveness indicators across industries between companies with high and low ESG scores (Table 7).

As for industry-based analysis, it is important that Tobin's Q in companies with higher ESG scores is significantly lower in all industries, except for health care, industrials, and utilities, meaning that these three industries are often overvalued, while others are undervalued. It might be the case because overvaluation may reflect the fact that investors overreact to higher ESG scores in these industries, pushing share prices up. Significantly higher return on equity is attributable to communication services, consumer discretionary, consumer staples, energy, IT, and materials industries, while the difference in ROE of the industrial, health care and real estate companies is not sufficient. It is statistically significant that the cost of capital in the communication and consumer services, as well as in health care, real estate and utilities industries is lower when the ESG score is higher. However, companies with higher ESG scores show higher cost of capital in IT industry. The difference across other industries is not significant, thus, higher ESG transparency does not mean lower cost of capital for them. Finally, better ESG performance increases the probability of paying dividends in communication services, consumer, energy, industrials, and real estate industries. In other industries, companies with different ESG scores pay dividends with the same probability.

Table 8. Difference in means analysis. Industry breakdown for S&P 500 companies

	ESG score *Above median*	*E score* *Above median*	*S score* *Above median*	*G score* *Above median*
Communication Services				
Tobin's Q	<***	<***	<***	<***
ROE	>***	>**	>***	>***
Cost of capital	<**	<**	<**	–
Dividends	>***	>***	>***	>***
Consumer Discretionary				
Tobin's Q	<***	<***	<***	<***
ROE	>***	>***	–	>***
Cost of capital	<**	<**	<**	<**
Dividends	>***	>***	>***	>***
Consumer Staples				
Tobin's Q	<***	<***	<***	<***
ROE	>***	–	>**	>***
Cost of capital	–	–	–	–
Dividends	>***	>**	>***	>***
Health care				
Tobin's Q	>***	>**	>**	>*
ROE	–	<**	–	–
Cost of capital	<*	–	<*	<*
Dividends	–	–	–	–

	ESG score Above median	E score Above median	S score Above median	G score Above median
Energy				
Tobin's Q	<**	<**	<***	<*
ROE	>***	>***	>***	>***
Cost of capital	–	–	–	–
Dividends	>***	>***	>***	>***
Industrials				
Tobin's Q	>***	>***	>***	–
ROE	–	–	<**	–
Cost of capital	–	–	–	–
Dividends	>**	>*	>**	>**
Information Technology				
Tobin's Q	<***	<***	<***	<**
ROE	>***	>***	>***	–
Cost of capital	>***	>**	>***	–
Dividends	–	–	<*	–
Materials				
Tobin's Q	<***	–	<***	<***
ROE	>***	>***	>***	>*
Cost of capital	–	<***	<**	–
Dividends	–	–	–	–
Real estate				
Tobin's Q	<***	<***	<***	–
ROE	–	–	–	–
Cost of capital	<*	<**	<*	–
Dividends	>*	>**	>*	>**
Utilities				
Tobin's Q	>***	>***	>***	<**
ROE	<**	<**	<***	–
Cost of capital	<**	<**	<***	–
Dividends	–	–	–	–

The table presents the results of the difference in means analysis. > denotes the fact that the indicator is higher for companies with above-median ESG performance. < denotes the fact that the indicator is lower for companies with above-median ESG performance. * denotes $p < 0.10$; ** denotes $p < 0.05$; and *** denotes $p < 0.01$.

European companies demonstrate a negative relationship between ESG performance and Tobin's Q for all industries except real estate, while ROE is lower for almost every industry except for health care. Effect on cost of capital is controversial in different industries, but mostly lower with better ESG performance. Only in consumer staples and health care can higher ESG scores lead to dividend payouts.

Table 9. Difference in means analysis. Industry breakdown for S&P 350 companies

	ESG score	E score	S score	G score
	Above median	Above median	Above median	Above median
Communication Services				
Tobin's Q	<***	<***	<***	<***
ROE	<***	<***	<***	<**
Cost of capital	<***	<***	<***	<*
Dividends	–	>**	–	–
Consumer Discretionary				
Tobin's Q	<***	<***	<***	<***
ROE	<***	<***	<**	<*
Cost of capital	<***	<***	<***	–
Dividends	–	–	>**	<**
Consumer Staples				
Tobin's Q	<***	<*	<***	–
ROE	>***	>***	–	>***
Cost of capital	>**	>***	–	–
Dividends	>***	>***	>**	–
Health care				
Tobin's Q	<***	<***	–	<***
ROE	>**	>***	>***	–
Cost of capital	–	>***	>***	–
Dividends	>***	>***	>***	–
Energy				
Tobin's Q	<**	–	<***	<***
ROE	–	–	–	–
Cost of capital	>*	<**	<**	>**
Dividends	–	–	–	–
Industrials				
Tobin's Q	<**	<**	<**	<***
ROE	–	–	>**	<*

	ESG score Above median	E score Above median	S score Above median	G score Above median
Cost of capital	–	–	–	–
Dividends	–	–	>***	–
Information Technology				
Tobin's Q	<***	<***	<*	<*
ROE	–	<***	–	–
Cost of capital	–	–	–	–
Dividends	–	–	>*	<*
Materials				
Tobin's Q	<***	<*	<***	<***
ROE	<***	–	<***	<***
Cost of capital	<**	<*	<*	<***
Dividends	–	<**	<*	–
Real estate				
Tobin's Q	>**	>***	–	–
ROE	<**	<**	<**	<**
Cost of capital	<***	<*	–	–
Cividends	–	–	–	–
Utilities				
Tobin's Q	<**	<***	–	–
ROE	<**	<***	–	>*
Cost of capital	–	<***	<***	>***
Dividends	–	–	–	–

Panel regression analysis

While building panel regressions, we chose between pooled OLS, fixed effects and random effects models' specifications. Breusch-Pagan Lagrange multiplier test allowed us to conclude that the difference across units is significant, and the panel effect is present. After that, we ran a Hausman test and concluded that random effects models are not consistent in our case, which is why we implemented fixed effects models. To ensure that our models do not suffer from omitted variable bias, we used a RESET-test for panel data, which confirmed that our models are specified. Finally, we noted the fact that all models show joint significance, measured by F statistics.

Table 10 demonstrates fixed effects regression results on the S&P 500 companies' sample, exploring the relationship between ESG scores and investment attractiveness measured by Tobin's Q, ROE, cost of capital and dividend payment probability for the American market. We hypothesized that higher ESG scores will lead to higher Tobin's Q, ROE, and dividend payout probability, while the cost of capital should be reduced. We revealed that only after 2015 better ESG performance positively affects Tobin's Q and dividend payment probability, which is supported by [11; 12; 18;23;24]. However, we discovered that ESG scores do not significantly affect ROE and cost of capital, which is in line with [13; 29;30]. Such a result may be explained by the fact that ESG scores send good investment signals to markets, increasing Tobin's Q and dividend payout probability because of sustainable governance practices. However, better ESG performance might not affect internal efficiency indicators and cost of capital, since credit agencies are not prone to immediately and significantly change their outlooks in response to a better ESG performance. Moreover, according to some research, sometimes the absence of ESG disclosure can affect metrics such as cost of capital, but ESG disclosure itself can lower the cost of capital [13].

Table 10. Fixed effect regression. ESG score influence on investments attractiveness for S&P 500 companies

	Tobin's Q	ROE	Cost of capital	Dividend payment
ESG score*2015	0.054*	–0.081	0.011	0.600***
Std. dev	0.031	0.060	0.073	0.225
ESG score	–0.019	–0.039	0.041	0.235
Std. dev	0.025	0.042	0.073	0.772
Size	–0.655***	–0.134**	–0.108	7.220***
Std. dev	0.032	0.067	0.073	2.182
Leverage	0.027*	0.086***	–0.148**	1.656**
Std. dev	0.016	0.033	0.069	0.655
Liquidity	–0.022			2.747**
Std. dev	0.025			1.374
ROA	–0.038**		0.184**	4.032***
Std. dev	0.018		0.090	1.426
Growth	–0.003			–1.658**
Std. dev	0.018			0.838
Div. payments	–0.001		–0.012	
Std. dev	0.003		0.010	
Capex	–0.009		0.002	–4.493***
Std. dev	0.017		0.024	1.504
Profit margin		0.073***		
Std. dev		0.025		
Asset turnover		0.411***		
Std. dev		0.081		
Life cycle		0.117***		0.908
Std. dev		0.03		1.421
Interest coverage			–0.212***	
Std. Dev			0.066	
Beta			0.327***	
Std. dev			0.038	
Market to book				–2.616*
Std. dev				1.367
CFO				–2.284**

	Tobin's Q	ROE	Cost of capital	Dividend payment
Std. dev				1.042
Constant	16.429***	6.109***	4.189**	
Std. dev	0.739	1.5559	1.861	
Year effect	Yes	Yes	Yes	No
N	1635	2160	1672	
F	81.26	12.70	34.46	
R (within)	0.73	0.18	0.49	

The table presents the results of the fixed effects regression analysis. * denotes p < 0.10; ** denotes p < 0.05; and *** denotes p < 0.01.

As for European companies (Table 11), there is evidence that better ESG performance overall and specifically after 2015 also has a positive influence on Tobin's Q, albeit the effect on other indicators is not significant. The weak effect of ESG performance on investment attractiveness indicators for the European market may be explained by the fact that the European companies' ESG results on average outperform the American companies' scores, which may mean that the investment community in Europe positively reacts to ESG performance in terms of valuation, but this performance does not guarantee that European companies will pay dividends, exhibit higher ROE or lower cost of capital.

Table 11. Fixed effect regression. ESG score influence on investments attractiveness for S&P 350 companies

	Tobin's Q	ROE	Cost of capital	Dividend payment
ESG score*2015	0.045*	–0.083	–0.018	–0.087
Std. dev	0.023	0.102	0.070	0.100
ESG score	0.059***	0.019	0.098	0.668
Std. dev	–0.021	0.099	0.061	1.440
Size	–0.804***	0.035	0.015	1.662
Std. dev	0.028	0.082	0.055	1.808
Leverage	0.035***	0.093***	–0.057**	–0.668
Std. dev	0.010	0.028	0.026	0.546
Liquidity	0.013			–1.505
Std. dev	0.012			1.137
ROA	–0.017***		0.462***	2.286***
Std. dev	0.006		0.042	0.528
Growth	–0.011			0.437
Std. dev	0.012			1.287
Div. payments	0.006		–0.022	
Std. dev	0.004		0.019	
Capex	–0.015**		–0.003	–0.073

	Tobin's Q	ROE	Cost of capital	Dividend payment
Std. dev	0.007		0.022	0.435
Profit margin		0.215***		
Std. dev		0.025		
Asset turnover		0.894***		
Std. dev		0.095		
Life cycle		0.03		1.085**
Std. dev		0.039		0.517
Interest coverage			–0.039	
Std. dev			0.024	
Beta			0	
Std. dev				
Market to book				2.627*
Std. dev				1.459
CFO				–0.004
Std. dev				0.464
Constant	19.624***	1.907	0.776	
Std. dev	0.678	1.909	1.323	
Year effect	Yes	Yes	Yes	No
N	1614	2048	1729	
F	177.42	14.76	13.04	
R (within)	0.91	0.28	0.27	

The table presents the results of the fixed effects regression analysis. * denotes $p < 0.10$; ** denotes $p < 0.05$; and *** denotes $p < 0.01$.

According to regression results presented in Table 12, we are unable to confirm the second hypothesis that ESG scores' influence on investment attractiveness is more pronounced for industrial, materials and energy US companies either overall or after 2015. This implies that industrial, materials and energy companies in the S&P500 index do not demonstrate greater investment attractiveness indicators because of their ESG scores.

Table 12. Fixed effect regression. Influence of ESG scores in industrial S&P 500 companies

	Tobin's Q	ROE	Cost of capital	Dividend payment
Esg*industrial*2015	0.007	–0.014	–0.091	3.394
Std. dev	0.005	0.014	–0.108	2.839
Esg*industrial	0.024	–0.045	–0.091	–1.353
Std. dev	–0.048	–0.084	–0.108	–1.954
ESG score*2015	0.056	–0.081	0.066	0.512**

	Tobin's Q	ROE	Cost of capital	Dividend payment
Std. dev	0.031	0.061	–0.083	0.237
Year effect	Yes	Yes	Yes	No
N	1635	2160	1672	
F	80.75	11.91	34.11	
R (within)	0.73	0.18	0.50	

The table presents the results of the fixed effects regression analysis. * denotes p < 0.10; ** denotes p < 0.05; and *** denotes p < 0.01.

Unlike the US market, there is evidence for European companies that ESG performance in industrial companies decreases Tobin's Q, which may be a sign of a fairer valuation of industrial companies due to higher transparency. Following 2015, cost of capital of industrial companies was slightly reduced in response to an increase in ESG scores. Probability of paying dividends decreased as well, which may imply that industrial companies prefer to invest in ESG issues rather than pay dividends.

Table 13. Fixed effect regression. Influence of ESG scores in industrial S&P 350 companies

	Tobin's Q	ROE	Cost of capital	Dividend payment
Esg*industrial*2015	0.002	-0.01	-0.014**	–0.424**
Std. dev	0.003	0.013	–0.006	0.208
Esg*industrial	–0.077***	–0.045	–0.091	–1.353
Std. dev	0.027	–0.084	–0.108	–1.954
ESG score*2015	0.048*	–0.096	–0.003	0.064
Std. dev	0.024	0.105	0.067	0.123
Year effect	Yes	Yes	Yes	No
N	1614	2048	1729	
F	171.0003	14.00123	12.96319	
R (within)	0.91	0.28	0.27	

The table presents the results of the fixed effects regression analysis. * denotes p < 0.10; ** denotes p < 0.05; and *** denotes p < 0.01.

Despite the fact that the overall ESG score does not improve investment attractiveness indicators in energy, materials, and industrial companies, it can benefit the separate pillars. For example, an increase in environmental score is expected to send a positive sign to investors in ecologically unfriendly industries. The same logic can be applied to the social pillar because industrial companies usually offer less safe labour conditions than other industries. An extended analysis with a cross effect for the S&P 500 companies shows that better performance in environment and social pillars generally decreases Tobin's Q and ROE. Meanwhile, only a negative relationship between ROE and environmental pillar was discovered for industrial companies, which may mean that higher spending on environmental projects reduces profits and ROE. For other indicators we found that the relationship between ESG scores and performance indicators in industrial, energy and materials companies is the same as in other sectors (Table 14).

Table 14. Fixed effect regression. Influence of ESG pillars in industrial S&P 500 companies

	Tobin's Q	ROE	Cost of capital	Dividend payment
E*industrial*2015	–0.036	–0.146*	0.076	–2.422
Std. dev	0.050	0.083	0.094	15.713
S*industrial*2015	0.110	0.131	0.036	15.846
Std. dev	0.070	0.129	0.159	–17.336
G*industrial*2015	–0.071	–0.007	–0.084	–10.239
Std. dev	0.048	0.107	0.131	–12.427
E score*2015	–0.040**	–0.093*	–0.001	14.173
Std. dev	0.017	0.055	0.076	15.366
S score*2015	–0.095***	–0.186*	0.014	–1.434
Std. dev	0.033	0.101	0.161	18.564
G score*2015	0.016	–0.048	0.051	7.489
Std. dev	0.025	0.082	0.080	9.778
Year effect	Yes	Yes	Yes	No
N	1552	2025	1575	
F	61.03	8.09	31.50	
R (within)	0.72	0.18	0.51	

The table presents the results of the fixed effects regression analysis. * denotes $p < 0.10$; ** denotes $p < 0.05$; and *** denotes $p < 0.01$.

The same analysis for the European S&P 350 companies indicates that the relationship between ESG scores and performance indicators in industrial, energy and materials companies is the same as in other sectors.

Table 15. Fixed effect regression. Influence of ESG pillars in industrial S&P 350 companies

	Tobin's Q	ROE	Cost of capital	Dividend payment
E*industrial*2015	0.001	0.135	0.023	0.729
Std. dev	0.026	0.161	0.095	2.880
S*industrial*2015	–0.011	–0.076	–0.053	–1.010
Std. dev	0.030	0.156	0.113	4.136
G*industrial*2015	0.010	–0.068	0.046	–0.169
Std. dev	0.019	0.093	0.067	3.424
E score*2015	0.025	–0.154	0.001	–1.543
Std. dev	0.019	0.099	0.067	2.493
S score*2015	–0.029	0.061	–0.031	0.663
Std. dev	0.029	0.127	0.100	4.044

	Tobin's Q	ROE	Cost of capital	Dividend payment
G score*2015	0.027**	0.028	0.005	1.691
Std. dev	0.013	0.066	0.054	2.394
Year effect	Yes	Yes	Yes	No
N	1614	2048	1729	
F	142.30	11.82	11.17	
R (within)	0.91	0.29	0.28	

The table presents the results of the fixed effects regression analysis. * denotes p < 0.10; ** denotes p < 0.05; and *** denotes p < 0.01.

Propensity score matching

The authors fail to find significant relationships between ESG scores and Tobin's Q, ROE, cost of capital and probability of paying dividends. However, there may a potential causality effect, according to which different firm characteristics such as size, capital structure, expenditures and others may affect the ESG score (the fact that some companies have ESG scores and others do not). Since our dataset does not contain companies without ESG scores, we divided the sample into companies with above-median ESG scores (treatment group) and below-median ESG scores (control group). We used the propensity score matching modelling to find out whether ESG scores influence investment attractiveness regardless of company characteristics. In other words, we sought to find out how much investment attractiveness factors change in companies whose ESG score increases from below-median to above-median.

Table 16. Propensity score matching estimation for S&P 500

	Tobin's Q	ROE	Cost of capital	Dividend payment
ESG score	–0.427***	2.382	–0.654**	0.046***
Std. dev	0.164	1.967	0.321	0.014
E pillar	0.142	0.748	–0.372	0.049***
Std. dev	0.222	1.21	0.302	0.017
S pillar	–0.346**	1.029	–0.804**	0.014
Std. dev	0.142	2.114	0.321	0.013
G pillar	–0.205*	–0.264	–0.442**	0.017
Std. dev	0.114	1.245	0.181	0.014

The table presents the results of propensity score matching analysis. * denotes p < 0.10; ** denotes p < 0.05; and *** denotes p < 0.01.

Propensity score matching estimation shows the results regardless of company characteristics that may affect ESG scores and dependent variables, thereby causing endogeneity. According to Table 16, if an American company was to increase its ESG score to the above-median level from a below-median level, its Tobin's Q will decrease by 0.43 on average, and this result is significant. Increasing the environmental pillar would not significantly decrease Tobin's Q, while working on social and governance aspects can be useful. This result complies with the difference in means analysis, which states that companies with higher ESG scores on average show lower Tobin's Q. Moreover, ESG improvement according to the PSM model leads up to a 0.65 decrease in cost of capital. Higher contribution of the social and governance pillars supports the idea that the cost of capital decreases because debtholders and shareholders are better protected by the strong governance system, and discontinuity and sustainability of operations is supported by the fact that a company cares about its employees and society. Higher ESG scores can also improve dividend payment probability due to improvement in the environmental section, but do not significantly influence return on equity.

Table 17. Propensity score matching estimation for S&P 350

	Tobin's Q	ROE	Cost of capital	Dividend payment
ESG score	–0.719***	1.52	–0.360**	0.003
Sstd. dev	0.238	0.934	–0.162	0.011
E pillar	–0.292	0.812	–0.018	0.037
Std. dev	0.265	1.159	0.161	0.017
S pillar	0.056	4.136***	–0.100	0.021
Std. dev	0.269	0.737	0.186	0.012
G pillar	–0.275	–0.081	0.157	–0.004
Std. dev	0.191	0.862	0.162	0.012

The table presents the results of propensity score matching analysis. * denotes $p < 0.10$; ** denotes $p < 0.05$; and *** denotes $p < 0.01$.

The results retrieved for European companies are similar with the results for American companies. Transition to the above-median ESG score group will also reduce Tobin's Q and cost of capital. However, there is no evidence that transition to the higher ESG score group will affect dividend payout probability or that better performance in separate pillars will significantly affect investment attractiveness. Considering that European companies on average show better median ESG performance, a transition to a higher level will not lead to a change in investment attractiveness, while American companies comparatively underperform, and investors may positively react to transition even to median levels.

Discussion and Conclusions

In this paper, we sought to find an answer to the question of whether ESG scores affect the investment attractiveness of public companies, measured by Tobin's Q, cost of capital, return on equity and dividend payout probability. Another relevant question was whether this influence was more pronounced for industrial, energy and materials companies included in S&P 500 index and S&P 350 Europe index between 2010 and 2020. These questions have arisen due to the growing importance of ESG issues, followed by higher pressure from the investment community on the companies that now need to incorporate ESG performance indicators into their long-run strategies to ensure future sustainability.

Two main hypotheses were put forward in this research. The first one states that companies with better ESG performance tend to have higher investment attractiveness indicators, expressed by higher Tobin's Q (thus, being more valued), higher return on equity (being more profitable) and a higher probability of paying dividends (thus, ensuring stable returns to shareholders). On the other hand, higher ESG scores should lower the cost of capital due to information asymmetry reduction and lowered risks. The provided difference in means analysis has shown that companies with above-median ESG scores have significantly lower Tobin's Q and cost of debt, and probability of paying dividends is significantly higher for both American and European companies. However, S&P 350 Europe companies have lower return on equity in response to better ESG performance, while S&P 500 US companies show higher profitability. These results were also robust for the industry-based analysis.

Panel regression analysis did not reveal any significant influence of the ESG score or its pillars on the investment attractiveness indicators, however, under the assumption that the result might be influenced by the Paris agreement, which was signed in 2015, we found that after 2015 investors became more responsive to changes in ESG scores. Thus, for US companies we can confirm that ESG performance positively affects Tobin's Q and probability of paying dividends after 2015, while for European companies there is also evidence that higher ESG scores lead to a higher Tobin's Q. Thus, these results partly allow us to confirm our first hypotheses. The results support the opinion that ESG performance may be more influential in the long-term, rather than in the present [9].

The Chow test was carried out to test the stability of the regression model parameters, the presence of structural shifts in the sample,. This made it possible to test sample heterogeneity in the context of the regression model.

According to the results of the Chow test, after 2015 there was a structural shift, that is, the fundamental characteristics of the system in question have changed over time. According to the test results, the signing of the 2015 Paris Agreement on climate change significantly affected the state of the market. A more than 10-fold excess of the critical value was found, which confirms the hypothesis of the presence of a structural shift. According to the decision made, the reduction of greenhouse gas emissions was supposed to lead to energy security and technological

development. We can assume that this was a new reality in global energy and the creation of environmental security, which was mandatory for all participants planning future development. Thus, it is possible to find a connection between updating sustainability and increasing ESG ratings and political/legislative decisions related to environmental protection.

To mitigate the causality effect, we perform propensity score matching estimation that assesses the influence of ESG scores on investment attractiveness indicators regardless of company characteristics. For US companies, we conclude that transition from a below-median ESG score to the above-median ESG score on average decreases Tobin's Q and leads to a fairer valuation, also decreasing the cost of capital and increasing the probability of paying dividends. On the other hand, for European companies, we also found that Tobin's Q on average decreases after the transition to the above-median score groups, along with cost of capital. Other indicators may not react to higher ESG scores because S&P 350 Europe companies initially had higher average ESG scores than S&P 500 US companies.

Our results regarding Tobin's Q are in line with those of the authors who found that ESG performance increases Tobin's Q [1; 10; 12; 18; 23; 24]. However, we found that a transition to the group with above-median ESG scores decreases Tobin's Q. We explain our results by the fact that the companies in our sample are typically overvalued, and better ESG performance may increase transparency, due to which valuation of companies becomes more justified.

The influence of ESG performance on return on equity is not significant, which may provide evidence that investments in ESG may be paid back over a longer period than one year. Thus, we imply that in the short run ESG performance cannot drive profits up and significantly increase ROE, which is in line with [23].

Like [13], we believe that the cost of capital is not affected by ESG performance, which implies that ESG scores are already incorporated in the cost of capital, and a slight improvement year on year does not change the cost of capital in the following year.

Finally, the authors found a positive relationship between ESG scores and dividend payouts [20; 27; 28], which is in line with our findings regarding the US market, but we can state that in regard to the European market, we are in line with the opinion of Matos et al. [30], who found that the ESG score has no influence on the dividend dummy variable. The conclusion that the probability of paying dividends does not increase in response to better ESG performance may imply that companies direct more cash flow to ESG projects rather than to dividends.

The second hypothesis states that the influence of ESG scores is more pronounced in industrial, energy and materials industries. The difference in means analysis provided the results that ESG scores across the industries are different. Panel regression analysis made it clear that the influence of the ESG score and its pillars on investment attractiveness indicators in the industrial sector is the same as in other industries for the US market; this is why we failed to confirm the second hypothesis in line with [31]. The intuition behind this result might be that industrial companies already have above-median ESG scores and perform better than companies from the IT industry, among others. This is why an increase in the ESG score or its pillars does not cause a positive reaction from the investment community. The research regarding industry-based ESG analysis provides evidence that contribution of ESG to the energy and industrial companies is stronger [21; 24; 29], and we were able to confirm that better ESG performance decreases cost of capital and probability of paying dividends in the European industrial companies. This implies that credit institutions in Europe may exert more pressure on industrial companies and reward them by showing better ESG performance. As for the dividends, companies may choose to realize ESG initiatives at the shareholders' expense and pay less dividends.

Even though according to our results a change in ESG scores does not imply a change in Tobin's Q, ROE, cost of capital or dividend payout probability, a transition from below-median ESG score to above-median ESG score may result in better investment attractiveness indicators.

The general conclusions of the comparative analyses for European and American companies coincided. The transition to high ESG results in a decrease in Tobin's Q and the cost of capital. However, there is no evidence that achieving higher ESG ratios affects the likelihood of paying dividends, and higher performance of some individual components will significantly affect investment attractiveness. European companies on average show the best median ESG performance, therefore, it can be assumed that high ESG ratings will not have a significant impact on the investment attractiveness of companies. At the same time, for US companies an increase in ESG ratings may have a positive impact on their investment attractiveness.

Despite some limitations, the research contributes to the existing knowledge by covering a wider time frame, taking into consideration a panel of investment attractiveness indicators, outlaying the analysis by ESG score pillars, and making an emphasis on the industrial sector. Moreover, it adds to the few papers that discuss propensity score matching model usage in the context of ESG scores.

From a practical point of view, our results suggest that managers of all companies in different industries pay strong attention to ESG performance because its role in investment decision-making is increasing, even though it is sometimes a fiduciary one. Better ESG performance allows to increase company valuation in the US and Europe, while a transition to an above-median score ensures lower cost of capital. Companies in the USA are advised to improve transparency about the social and governance projects for investors to make more accurate estimates, as well as for lenders to assess risks correctly and can help lower cost of capital.

Our study contributes to a better understanding of the impact of ESG integration on the companies' market value

in developed markets, and provides critical insight into differences in the impact of these factors as perceived by stakeholders. Even if some ESG components do not have a significant impact on increasing companies' investment attractiveness, the study can highlight certain global and individual features that should be considered by investors and analysts when making investment decisions or by managers when making decisions and implementing ESG strategies, taking into account stakeholder expectations.

In conclusion, stakeholder theory [14; 21] postulates that an increase in the ESG rating provides certain benefits to firms since it can increase their efficiency. The results of the study showed that this relationship is not fully confirmed by the behavior of market participants, since it will not sanction the overall monthly increase or decrease in ESG ratings, except during specific, contextual periods. This is an interesting result for company management, which can focus on a high ESG rating during periods of business reform or active investment activity. Results are also important for regulators and policy makers to increase the involvement of companies in pursuing an ESG strategy.

Future studies can be aimed at providing this analysis for other countries. It is interesting to examine the relationship between ESG and performance in Russia, but there is not enough data so far. Moreover, subsequent research may use more advanced methods for regression analysis and treatment effects, as well as incorporate other performance indicators.

References

1. MSCI ESG Research. (2020, November). MSCI ESG Ratings Methodology [Online]. Available at: https://www.msci.com/documents/ (Accessed 10 February 2021).
2. Amel-Zadeh, A., and Serafeim, G. (2018), 'Why and How Investors Use ESG Information: Evidence from a Global Survey', Financial Analysts Journal, vol. 74, no. 3, pp. 87-103.
3. Arabella Advisors. (2018). The Global Fossil Fuel Divestment and Clean Energy Investment Movement [Online]. Available at: https://www.arabellaadvisors.com (Accessed 20 March 2021).
4. World Bank Group. (2017, December 12). World Bank Group Announcements at One Planet Summit [Online]. Available at: https://www.worldbank.org/en/news/press-release/2017/12/12/ (Accessed 20 March 2021).
5. Bernow, S., Nuttall, R. (2020, May 26). Why ESG is here to stay [Online]. McKinsey&Company. Available at: https://www.mckinsey.com/business-functions/strategy-and-corporate-finance/our-insights/ (Accessed 15 March 2021).
6. Kell, G. (2018, July 11). The Remarkable Rise of ESG [Online]. Forbes. Available at: https://www.forbes.com/sites/georgkell/ (Accessed 8 February 2021).
7. Wagner, C., and Ballentine, C. (2020, October 25). Record Flows Pour Into ESG Funds as Their 'Wokeness' Is Debated [Online]. Available at: https://www.bloomberg.com/news/articles/ (Accessed 20 March 2021).
8. PwC. (2019). Older and wiser: Is responsible investment coming of age? Private Equity Responsible Investment Survey 2019 [Online]. Available at: https://www.pwc.com/gx/en/services/sustainability/ (Accessed 10 February 2021).
9. Armstrong, R. (2020, October 23). The fallacy of ESG investing [Online]. Financial Times. Available at: https://www.ft.com/content/ (Accessed 15 March 2021).
10. Bardos, K., Ertugrul, M., and Gao, L. (2020), 'Corporate social responsibility, product market perception, and firm value', Journal of Corporate Finance, vol. 62, pp. 1-18.
11. Fatemi, A., Glaum, M., and Kaiser, S. (2018), 'ESG performance and firm value: The moderating role of disclosure', Global Finance Journal, vol. 38, pp. 45-64.
12. Li, Y., Gong, M., Zhang, X., and Koh, L. (2018), 'The impact of environmental, social, and governance disclosure on firm value: The role of CEO power', The British Accounting Review, vol. 50, pp. 60-75.
13. Wong, W. C., Batten, J. A., and Ahmad, H. (2020), 'Does ESG certification add firm value?', Finance Research Letters, pp. 1-18.
14. Dhaliwal, D., Li, O. Z., Tsang, A., and Yang, Y. G. (2014), 'Corporate social responsibility disclosure and the cost of equity capital: The roles of stakeholder orientation and financial transparency', Journal of Accounting and Public Policy, vol. 33, no. 4, pp. 328-355.
15. Eliwa, Y., Aboud, A., and Saleh, S. (2019), 'ESG practices and the cost of debt: Evidence from EU countries', Critical Perspectives on Accounting, https://doi.org/10.1016/j.cpa.2019.102097.
16. S&P Global Ratings. (n.d.). ESG in Credit Ratings [Online]. Available at: https://www.spglobal.com/ratings/en/products-benefits/products/esg-in-credit-ratings (Accessed 21 March 2021).
17. Nauman, B. (2020, June 1). ESG pressure on dividend payouts to continue after crisis [Online]. FT. Available at: https://www.ft.com/content/ (Accessed 10 February 2021).
18. Rjiba, H., Jahmane, A., and Abid, I. (2020), 'Corporate social responsibility and firm value: Guiding through economic policy uncertainty', Finance Research Letters, vol. 35, pp. 1-7.
19. Nirino, N., Santoro, G., Miglietta, N., and Quaglia, R. (2021), 'Corporate controversies and company's financial performance: Exploring the moderating role

of ESG practices', Technological Forecasting & Social Change, vol. 162, pp. 1-7.

20. Cheung, A., Hu, M., and Schwiebert, J. (2018), 'Corporate social responsibility and dividend policy', Accounting and Finance, vol. 58, no. 3, pp. 787–816.
21. Alonso-Almeida, M., Rodrıguez-Anton, J., and Rubio-Andrada, L. (2012), 'Reasons for implementing certified quality systems and impact on performance: an analysis of the hotel industry', The Service Industries Journal, vol. 32 no. 6, pp. 919-936.
22. Velte, P. (2017), 'Does ESG Performance have an impact on financial performance? Evidence from Germany', Journal of global responsibility, vol. 80, no. 2, pp. 169-178.
23. Alareeni, B., and Hamdan, A. (2020), 'ESG impact on performance of US S&P 500-listed firms', Corporate Governance, vol. 20, no. 7, pp. 1409-1428.
24. Ortas, E., Alvarez, I., and Garayar, A. (2015), 'The Environmental, Social, Governance, and Financial Performance Effects on Companies that Adopt the United Nations Global Compact', Sustainability, vol. 7, pp. 1932-1956.
25. Landi, G., and Sciarelli, M. (2019), 'Towards a more ethical market: the impact of ESG rating on corporate financial performance', Social Responsibility Journal, vol. 15, no. 1, pp. 11-27.
26. Zhao, C., Guo Y., Yuan, J., Wu, M., Li, D., Zhou, Y., and Kang, J. (2018), 'ESG and Corporate Financial Performance: Empirical Evidence from China's Listed Power Generation Companies', Sustainability, vol. 10, pp. 1-18
27. Benlemlih, M. (2019), 'Corporate social responsibility and dividend policy', Research in International Business and Finance, vol. 47, pp. 114 - 138.
28. Samet, M., and Jarboui, A. (2017), 'Corporate social responsibility and payout decisions', Managerial Finance, vol. 43, pp. 982–998.
29. Taliento, M., Favino, C., and Netti, A. (2019), 'Impact of Environmental, Social, and Governance Information on Economic Performance: Evidence of a Corporate 'Sustainability Advantage' from Europe', Sustainability, vol. 11, pp. 1738 – 1764.
30. Matos, P., Barros, V., and Sarmento, J. (2020), 'Does ESG Affect the Stability of Dividend Policies in Europe?', Sustainability, vol. 12, no. 21, pp 8804.
31. Galbreath, G. (2013), ESG in Focus: The Australian Evidence, 'Journal of Business Ethics', 118, pp. 529-541.
32. Fell, J. (2001). What can Tobin's Q tell us about market stock valuation? European Central Bank Research.
33. Gugler, K., Mueller, D., and Yurtoglu, B. (2004), 'Marginal q, Tobin's q, Cash Flow, and Investment', Southern Economic Journal, vol. 70, no. 3, pp. 512-531.
34. Sustainanalytics. (n. d.). [Online]. Available at: https://www.sustainalytics.com/esg-data/ (Accessed 21 March 2021).
35. Chen, H., and Yang, S. (2020), 'Do Investors exaggerate corporate ESG information? Evidence of the ESG momentum effect in the Taiwanese market', Pacific-Basin Finance Journal, vol. 63, pp. 1-13.
36. Diamond, A., and Sekhon, J. (2013), 'Genetic Matching for Estimating Causal Effects: A General Multivariate Matching Method for Achieving Balance in Observational Studies', The Review of Economics and Statistics, vol. 95, no. 3, pp. 932-945.
37. Shipman, J., Swanquist, Q., and Whited, R. (2017), 'Propensity score matching in accounting research', Accounting. Review, vol. 92, pp. 213–244.

Contribution of the authors: the authors contributed equally to this article.

The authors declare no conflicts of interests.

The article **was submitted** 11.01.2022; **approved after reviewing** 12.02.2021; **accepted for publication** 30.03.2022.

DOI: https://doi.org/10.17323/j.jcfr.2073-0438.16.1.2022.65-82
JEL classification: F34, G24, G28, G31

Statistical Analysis of Assigning a Corporate Credit Rating with Regard to the Sovereign Rating in the Russian Federation

Elena Kopnova ✉
Candidate of Technical Sciences, Associate Professor in the Department of Statistics and Data Analysis, National Research University Higher School of Economics, Moscow, Russia,
ekopnova@hse.ru, ORCID

Anna Gracheva
Economist, Division of Macroeconomic Analysis and Forecast at the Monetary Policy Department, The Bank of Russia, Moscow, Russia,
grachevaaa@cbr.ru, ORCID

Abstract

The paper presents the results of a statistical study of the formation of a corporate credit rating, with regard to the sovereign rating. The research is based on the data from 19 non–financial companies in Russia's leading industries for 2014–2018. It is shown that the sovereign credit rating, despite the relaxation of the sovereign "ceiling" rule by Fitch, Moody's and S&P rating agencies in 1997, remains closely correlated to the risk level of Russian companies. The obtained results related to macroeconomic and idiosyncratic risk indicators denote the peculiarities of credit rating formation for Russian companies. In particular, in contrast to the results of similar studies, it reveals the negative effect of certain profitability and liquidity variables, as well as the country's foreign trade turnover on the corporate rating. It also demonstrates that a credit rating has a "short memory" – its current value is historically determined only by the level in the previous period.

This paper is of practical relevance for private and institutional investors and lenders that use credit ratings to form their own perception of the default risk level in the corporate sector.

Keywords: credit ratings, sovereign ceiling, sovereign risk, corporate risk, risk transmission

For citation: Kopnova, E., and Gracheva A. Statistical Analysis of Assigning a Corporate Credit Rating with Regard to the Sovereign Rating in the Russian Federation. *Journal of Corporate Finance Research.* 2022;16(1): 65-82. https://doi.org/10.17323/j.jcfr.2073-0438.16.1.2022.65-82

Introduction

According to methodology used by Fitch, Moody's and S&P rating agencies, corporate credit rating is defined on the basis of internal and external factors of the environment in which a company operates [1]. At the same time, the sovereign rating, along with characteristics of financial and operating performance and macroeconomic indicators, remains the key determinant of the corporate credit risk level. Corporate default risk may increase due to changes in sovereign rating, which contributes to the aggravation of negative processes in corporate financial and operating performance, and not due to the impairment of a company's fundamental indicators [2–5]. According to a vivid expression in [6], corporate credit rating is "contaminated" with sovereign risks. It is of special importance for the companies from emerging economies, including Russia, because for them the sovereign rating is a negative externality that increases the cost of borrowing and decreases capital inflow from private and institutional investors. In this paper we present the results of econometric modeling of the influence of corporate credit rating formation factors for Russian companies from the leading industries with regard to the sovereign rating.

Credit Rating: Definition, Measuring, Status of Studies

Credit rating is a comprehensive assessment of the subject's (a country or a company) status in terms of its creditworthiness, financial reliability and stability. Investors may use the credit rating when making investment decisions. However, it does not guarantee the expediency of cash investments because it is indicative of only one aspect of the borrower's standing – its creditworthiness [7]. The sovereign rating is often a reference point for raising investment in the public and private sectors, especially when debt is denominated in a foreign currency and traded in the international capital market. There are at least three channels for transferring the sovereign's credit risk to the private sector [8]. First, it is the destabilizing effect on the entire national economy, which may manifest itself as the strengthening of the public sector, capital outflow and an increase in the number of bankruptcies and liquidations of private financial and non-financial organizations. Second, a change in country risks is caused by government measures that directly determine the companies' ability to discharge their financial obligations, such as increased taxes or application of inflationary finance methods. Third, administrative measures which impose control over capital flow, including a partial or complete ban on currency trading for the corporate sector. The first two channels may demonstrate a direct connection between the corporate and sovereign ratings, however, they do not constitute proof that companies cannot have a credit rating that exceeds the sovereign rating. The last channel is used by Fitch, Moody's and S&P international rating agencies to substantiate the existence of the sovereign "ceiling". According to the policy of rating agencies, the sovereign "ceiling" exists due to the presence of direct (transmission) risk of government intervention for financial obligations in a foreign currency and due to the indirect sovereign (country) risk for financial obligations in the national currency. Direct risk is the probability that a government experiencing difficulties with servicing a foreign debt will impose restrictions on its repayment and even force solvent companies to suspend liability repayments in a foreign currency. Indirect risk is the risk of default on government debt denominated in national currency, which may be caused by the crash of a systemically important bank, among other things.

In 1997 the S&P agency loosened the sovereign "ceiling" policy in regard to the "dollarized" economies of Argentina, Panama and Uruguay. The reason for this step was that the government in highly dollarized countries is less prone to foreign exchange control in case of default on government debt, hence, its influence on corporate creditworthiness is minimal [9]. In 2001 the second wave of the "ceiling" rule relaxation took place after the experience of the zero transmission risk in Russia (1998), Pakistan (1998), Ecuador (1999) and Ukraine (2000) was analyzed. Moody's explained that credit rating assignment process was changed because, as a rule, governments do not impose restrictions on foreign currency payments for systemically important borrowers whose default would significantly damage the national economy [10]. In spite of the relaxation of the rule, corporate credit ratings that exceed the "ceiling" are still common [11].

The first credit ratings were assigned to emerging countries in the 1990s, when their debt instruments were offered at the global capital market for the first time. A sovereign credit rating is an important prerequisite for success in engaging foreign creditors on attractive terms. Without such a rating, investors automatically combine the maximum possible country risk and the risk premium, thus adding to the cost of debt servicing. The methodology used by Fitch, Moody's and S&P involves a two-stage assessment of sovereign credit risks [12; 13]. At the first stage, they evaluate the following factors: efficiency of the checks and balances system, power legitimacy, existence of civil society, mass media independence, diversification potential of the economic structure, economic growth prospects, national currency status in international payments, net public debt level. as well as flexibility of fiscal and monetary policy. Then the rating they have initially assigned is adjusted with regard to the country's credit reputation, its membership in a currency union, existence of highly liquid financial assets and degree of population confidence in the implemented monetary policy, which determined the possibility of applying unconventional monetary instruments during economic crises [1].

For the first time the issue of the sovereign "ceiling" was discussed in paper [14], which aimed to study whether the sovereign "ceiling" rule was used by investors in shaping their opinion on the borrower's credit risk level. The authors focus on the comparison of spreads of corporate and sovereign Eurobonds issued in emerging countries. An analysis showed that on average corporate debt is trad-

ed with a wider spread. In point of fact, it is indicative of implementing the sovereign "ceiling" policy when making investment decisions. Nevertheless, this result is sometimes incorrect. Narrow spreads of corporate Eurobonds are characteristic of the companies that profit from a large export base. A similar approach was applied in research [15]. The authors compared income of Southern African corporate and sovereign bonds denominated in the national currency and revealed that sovereign risk is a key determinant of the corporate risk premium level. The sovereign "ceiling" was exceeded only by several international corporations from the real sector of economy, while all Southern African financial companies failed to exceed it.

Papers [16; 17] study the influence of sovereign credit rating changes on changes in the credit ratings of banks and non-financial organizations. The methodology applied by Ferri et al. [16] is based on building a VECM model, which is used to detect a statistically significant positive correlation between corporate and sovereign ratings. The sovereign "ceiling" effect is most significant in emerging countries and in case of a decrease in the country credit rating. The model offered in research paper [17] was expanded by adding idiosyncratic risk indicators. The analysis results showed that unlike the sovereign rating, individual risk indicators are not significant factors in defining the default risk level.

The consequences of the 2007–2009 crisis resulted in impaired sovereign ratings in both emerging and developed economies. Thus, for the first time ever, the credit ratings of the USA and France dropped below "AAA". The issue of influence of the sovereign rating and the "ceiling" gained greater relevance again. Mohapatra et al. [18] compared credit ratings of corporate and government Eurobonds of emerging countries and concluded that only securitized bonds were able to exceed the sovereign "ceiling". However, the credit ratings of Eurobonds of non-financial companies issued during a crisis are largely correlated with the sovereign rating. So, it is impossible to obtain a rating which exceeds the country rating. The sovereign "ceiling" effect manifests itself most clearly in the countries with an authoritarian political regime and in connection with financial companies and their debt issuance. The latter is due to the fact that the real sector of economy has a lower average probability of default because of its right to raise prices during periods of decline in order to maintain the required solvency margin [19]. Influence of the sovereign rating is sustained and is observed even after taking into consideration individual and macroeconomic risk indicators.

The S&P rating agency considers the sovereign credit rating a two-stage assessment of quantitative and qualitative indicators that characterize economic and political stability in a country. However, the results of research [20] demonstrate that approximately 90% of the sovereign rating variation assigned by Moody's and S&P are actually due to macroeconomic indicators only. The significant factors include inflation, fiscal balance, current account, GDP growth rate, income per capita, country's debt/export ratio, dummy variables that determine the level of economic development and cases of national debt restructuring since 1970.

Conclusions made by R. Cantor and F. Packer [20] were used in this paper [8]. The authors showed that the extent of influence of the sovereign "ceiling" varies depending on the country's and industry sector's development levels. The nontraded sector of emerging countries, with cash flows usually denominated in the national currency, experiences the most significant pressure of the sovereign "ceiling". There is asymmetry of influence: the effect of the decreased sovereign credit rating is more significant for the corporate sector.

The credit rating of a company directly establishes the amount and cost of raising debt capital [21; 22], thus determining its financial and investment decisions [23–27]. This issue is considered in detail in paper [28]. The research objective was to demonstrate that changes in financial and investment policy may proceed from credit rating changes, not necessarily from fundamental company characteristics [29]. The sample was divided into the treatment and control groups[1]. According to the analysis results, in the year when the sovereign rating decreases, investments in the treatment and control group are reduced by 8.9 and 2.6% respectively. In the same period the treatment group decreases the issue of net liabilities by 5.1%, and the control group – by 2.3% [30]. Increased costs of debt servicing force the companies in the treatment group to make a statistically and economically significant increase of capital issuance the next year after the decrease of the sovereign rating. The reduction in investments and debt financing is the net effect of the impaired sovereign rating because both groups had similar dynamics for two years after its decrease.

The assertion made by rating agencies that sovereign credit rating is effective in forecasting government debt default [10], is not quite correct. For instance, international agencies faced criticism because they had failed to predict the Asian crisis (1997–1998), the crisis in Uruguay (2002) [31], and later – the global crisis of 2007–2009 [32]. The past experience of underestimating default resulted in the procyclical nature of credit ratings, i.e. their ability to aggravate economic and financial crises due to their excessive pessimism [3; 33; 34].

As for Russian literature, papers [1; 35–38] provide the most detailed analysis of credit rating formation for industrial companies. The authors' approach consists in the sequential study of the basic (only individual financial indicators) and supplemented (micro- and macroeconomic variables added) probit models of multiple choice with

[1] Treatment group comprises corporate issuers whose rating is not lower than the rating of their jurisdiction's sovereign.

Control group consists of corporate issuers whose fundamental indicators are close to those of the companies from the treatment group, however, their corporate rating is lower than the sovereign rating.

Huber-White standard errors. The sample comprised oil and gas, power-generating, iron and steel companies, and telecommunication carriers from developed and emerging countries. The results showed that statistically and economically significant quantitative determinants that have a positive impact on a company's creditworthiness are its market capitalization, return on assets, operating income margin and gross profit relative to short-term debt, i.e. the ability to generate cash flows sufficient to repay current liabilities [35]. The ratio of the volume of long-term obligations to capital, which characterizes the amount of loans and their security, has a significant adverse impact on the corporate credit estimate. According to the supplemented model, such environmental factors as GDP growth rate and openness of the economy contribute to a significant improvement of corporate credit ratings, while inflation decreases them [1]. The corruption level in a country has a negative, although unstable effect on corporate creditworthiness [38]. Paper [39] studies the role of qualitative characteristics of a borrower's activity: an industry's growth prospects, competitive performance, commercial goodwill, extent of dependence on government subsidies, corporate governance structure and its geographic diversity, which, as a rule, are used as adjusting indicators. It showed that the value of qualitative indicators increases greatly for corporate speculative-grade borrowers.

Thus, the results of previous research papers show that the sovereign rating is a significant factor in the corporate creditworthiness level in different countries. The extent of interrelation between the sovereign and corporate ratings depends on a country's development level, its political regime, economy sector and type of company's activities. Asymmetry of the country "ceiling" effect is observed: the influence manifests itself most prominently when the sovereign credit rating is decreased, as well as for the companies whose credit rating is not below the sovereign rating.

The objective of this paper is to define the extent of influence of the primary rating formation factors on corporate credit rating formation with regard to the role of the sovereign rating. The following hypotheses are among the main verified assumptions:

- There is a statistically significant direct relationship between the corporate and sovereign credit ratings of Russian companies;
- Financial independence indicators of companies have a positive impact on the formation of their credit rating;
- Economic efficiency indicators have a positive impact on companies' creditworthiness;
- Liquidity indicators also have a positive influence on creditworthiness;
- Contribution of the macroeconomic environment factors to corporate creditworthiness is statistically significant;
- There is no statistically significant long-term succession of the corporate credit rating.

Data

The sample is a well-balanced panel of 19 publicly traded non-financial companies that operate in the leading Russian industries: metallurgic, oil-and-gas extraction, chemical and power-generating sectors. See the list of companies in the Appendix (Table P1). Company eligibility criteria were as follows: 1) the presence of a Fitch rating as of the sample formation date; 2) affiliation with the abovementioned industries; 3) availability of financial and market indicators for the period in question; 4) similar value of gross assets of the companies under consideration; 5) use of IFRS[2] for the disclosure of financial and accounting information. IFRS guarantees high quality and comparability of data in the studied years. The observation period is from 2014 to 2018. There is a problem with data completeness and consistency for the country and corporate ratings. International rating agencies entered the Russian financial services market in 1996, but two years later their operations were suspended due to the "rouble crisis" and were resumed only in 2003. The number of rating companies grew in 2005 when for the first time Russia was assigned an investment-grade credit rating. Thus, a short history of credit rating assignment results in the lack of data even in the core Russian industries. Besides, it is impossible to resolve the data incompleteness problem for *Cor_Rtg* and *Sov_Rtg* variables by standard imputed data methods, therefore the sample and the time horizon were chosen in a manner that prevents omission of data on sovereign and corporate ratings. The 2014–2018 period is characterized by an unsettling market situation, however, apart from the effect of macroeconomic perturbations, credit ratings also account for the effectiveness of the subject's (countries' and companies') response. In the period in question a significant decrease (by two positions down to "BB-") of Russia's sovereign rating occurred in 2016 due to the exacerbation of the Ukrainian crisis, the sanctions imposed on Russia and counter-sanctions. However, it has no significant effect on corporate creditworthiness[3]. First of all, the decision of the international rating agencies was probably politically charged, and second, the risks of a drop in credit ratings of Russia and its companies have already been taken into consideration by market players in price quotes for Russian assets.

Sovereign and corporate credit ratings are the indicators designated by a letter according to a rating scale. In this paper we used the ratings assigned by the Fitch international agency, which covers the majority of Russian raw materials

[2] IFRS – International Financial Reporting Standards.

[3] This assumption was verified by the applied methodology of panel data modelling by comparing individual effects in time for 2016 and the rest period. The hypothesis of mathematical expectations equality for these effects was not rejected with error probability of 0.01.

companies. According to this agency's rating scale, credit ratings vary from "AAA" to "D". However, the studied sample is limited and does not have the full set of rating values. The absence of default ratings ("D") from the sample is not a rigid restriction because the "D" rating is largely defined by the factors other than the investment and upper sub-investment grades [40]. For the purpose of analysis, we introduced the encoding method in compliance with Basel II recommendations, which state that a high rating corresponds to a smaller numerical value (Table 1) [8; 35]. Therefore, the factors to which negative regression coefficients correspond in econometric models, apart from the corporate and sovereign rating variables, have a positive influence on the credit rating and vice versa.

Table 1. Rating scale encoding

Credit rating	Assigned value
BBB	0
BBB–	1
BB+	2
BB	3
BB–	4
B+	5

In order to account for currency risk, we used only long-term ratings in foreign currency (US dollars). The paper considers only the credit rating of the issuer (not a specific issue), which reveals the ability and readiness of the subject (country or company) to fulfill its financial obligations. The issuer's credit rating leaves out the nature and conditions of a specific debt instrument, its status in case of bankruptcy, warrants, insurance, and other properties of a particular obligation.

Table 2 presents the system of indicators used in the paper. The choice of explanatory microeconomic indicators is made on the basis of the experience of Fabozzi et al. [41] and Karminsky et al. [35–37; 42]. It indicates that corporate credit risk is characterized by such factors as its size, economic efficiency, debt load, liquidity, as well as cash flow amount and pattern, and the ability to service financial obligations. Databases of SPARK and Cbonds information agencies were used to create the system of idiosyncratic risk indicators. Macroeconomic indicators that measure the level of sovereign risk have been selected on the basis of research paper [20]. The data was obtained in publicly available databases of the IMF and the Central Bank of the Russian Federation. "+" and "-" in Table 2 designate the assumptions related to the expected influence of each factor, which were based on the results of the studies mentioned in the literature review.

Table 2. System of indicators used in the analysis

Group	Indicator	Designations	UOM	Expected effect of influence on the corporate rating
Country risk	Inflation	*INFL*	% per year	–
	Real GDP growth	*GDP_gr*	% per year	+
	Current transactions account	*CA*	% of GDP	–/+
	Gross public debt	*GGD*	% of GDP	–
	Per capita GDP	*GDP*	PPP, billion US dollars, natural logarithm	+
	Fiscal balance	*FB*	% of GDP	–
	Sovereign rating	*Sov_Rtg*	0 – the best value; 5 – the worst value	+
Corporate individual risk	Company size	*Size*	billion US dollars, natural logarithm	–/+
	Return on assets	*ROA*	% per year	+
	Financial leverage	*LEV*	% per year	–
	Equity capital / gross assets	*EA*	% per year	+

Group	Indicator	Designations	UOM	Expected effect of influence on the corporate rating
Corporate individual risk	Current liquidity	*QR*	% per year	+
	EBIT / interest payable	*DC*	% per year	+
	Undistributed profits (loss) / gross assets	*REA*	% per year	+
	Net working capital / gross assets	*WCA*	% per year	+

The Appendix (Table P2 and P3) contains an example of descriptive statistics for variables: for microeconomic variables – as at 2018, for macroeconomic variables – from 2014 to 2018. The variation coefficient of the *Size* variable demonstrates the homogeneity of companies in the amount of gross assets, however, their financial indicators vary greatly (see, for example, the *REA* variable) depending on the industry sector, their market share and financial and business operations' history. A significant difference between the minimal and maximum values of *INFL* is caused by the 2014 economic sanctions and the rouble crash, as well as by the transition to the inflation targeting regime, which resulted in a two-fold inflation decrease from 15.5% to 7% in 2016. A negative mean value of *FB* is indicative of the budget deficit in the studied period, which has been caused by a slump in oil-and-gas income in 2014, accompanied by increased expenses for the defense industry, support of the public administration office and social maintenance. Analysis of Pearson paired correlation coefficients between the considered factors indicates a significant correlation between certain macroeconomic factors, on the one hand, and, as a rule, an insignificant correlation between idiosyncratic risk indicators, on the other (see Appendix, Table P3). Atypical observations revealed as a result of construction of box plots for *QR* and *DC* were not eliminated.

Methodology

In order to study the influence of micro- and macroeconomic factors on the formation of the corporate rating with regard to the sovereign rating, we applied the econometric modeling methodology, which allows to measure ratings in the interval scale and use linear regression models (see, for example, [8; 20; 28]). The conclusions based on modeling results are premised on the assessment of the marginal effect of the sovereign rating value. We used the models evaluated on the basis of panel data as one-dimensional ones: the fixed effects model (FE model), the Hausman-Taylor model [43], the dynamic model, as well as a regression equations system. The Hausman-Taylor model and the simultaneous equations system have been applied in order to take into consideration the problem of endogeneity of the sovereign rating in the regression. The dynamic model allowed to define the level of historic succession of corporate risk. When assessing the models, we controlled the theoretically possible parameter estimator bias by verifying the convergence of interval estimate for the abovementioned models. We interpreted the results of the model that yielded the largest number of statistically significant estimates. In order to confirm the results of the analysis that utilized the abovementioned models, we also evaluated the ordered multiple-choice model, which is common in such rating analysis (see, for example, [40]). Note that in all considered models we used the same set of variables adjusted by eliminating regressors with statistically insignificant (0.05) assessments of coefficients in each specific model. Then we described the specification of those models indicating identification and quality assessment methods.

We considered the typical specifications of the FE model [44] (model 1):

$$y_{it} = \alpha_i + x_{it}\beta + \varepsilon_{it},$$

where α_t is the fixed individual effect of i company; $x_{it} = (x_{1,it},...,x_{k,it})$ – regressors' vector; β – regression coefficients' vector; ε_{it} – residuals.

$$E[\varepsilon_{it}\,|x_{l,js}] = 0,\ Cov[\varepsilon_{it},\varepsilon_{js}] = \begin{cases}\sigma_\varepsilon^2, & i=j,\quad t=s\\ 0, & \text{otherwise}\end{cases}$$

$$\varepsilon_{it} \sim N(0,\sigma_\varepsilon^2)$$

$$l = 1,2,...,k \quad i,j = 1,2,...,n \quad t,s = 1,2,...,T.$$

The model utilizes indicator designations introduced in Table 2:

$$x_1 = Size,\ x_2 = ROA,\ x_3 = DC \text{ и } x_4 = Sov\_Rtg,\ k = 4.$$

The model was evaluated by the least squares method (LSM) with adjustment of the covariance matrix of parameter estimators by the Beck-Katz method [45] and weighted LSM. The multicollinearity problem was resolved by a step-by-step addition of loosely correlated indicators in the regression equation. We tested the correctness of the model specification by applying the Wald test to compare with the pooled model and the Hausman test to compare with the random effects model (RE model). Model adequacy was verified on the basis of statistical significance of the model as a whole and by testing regression residuals for absence of heteroscedasticity (Breusch-Pagan test), 1st order autocorrelation (Durbin-Watson test, Wooldridge test), cross-sectional correlation (Pesaran test), and compliance with the normal law of distribution (Jarque-Bera).

The fixed effects model allows to detect a company's individual credit risk, however, its plausible evaluation is difficult because of the problem of sovereign rating endogeneity. which is apparent in the mutual influence of the sovereign and corporate ratings. On the one hand, public debt default causes national currency devaluation, which is accompanied by hyperinflation, contraction of the bank system and increased political distrust, social tension and reputational risks, which inevitably impair companies' financial stability. The sovereign obligation payment history directly determines the loan cost for the corporate sector. Each subsequent default of a serial non-payer incurs a loss of an increasingly smaller share of favorable credit reputation and increased debt servicing expenses. On the other hand, bankruptcy of systemic companies results in decreased industrial output, contraction of target markets, rise in unemployment and deterioration in demand and loss of budget revenues, thus undermining a country's creditworthiness and solvency.

The Hausman-Taylor model (model 2) was used in the paper according to the basic specification that accounted for individual time effects, which allow to monitor the instability of the dependent variable.

$$y_{it} = \xi_t + x_{1,it}\beta_1 + x_{2,it}\beta_2 + w_{1,t}\gamma_1 + w_{2,t}\gamma_2 + \varepsilon_{it},$$

where ξ_τ is the individual effect of t year; vectors $x_{1,t\tau} = (x_{11,it},...,x_{1k_1,it})$ and $x_{2,it} = (x_{21,it},...,x_{2k_2,it})$ comprise regressors that change subject to subject and vary with time;

vectors $w_{1,t} = (w_{11,t},...,w_{1q_1,t})$ and $w_{2,t} = (w_{21,t},...,w_{2q_2,t})$ comprise regressors invariant in relation to the subject in the observation period; $\beta_1, \beta_2, \gamma_1$ and γ_2 are vectors of regression coefficients; ε_{it} – residuals.

$Cov[\varepsilon_{it}, x_{1l_1,it}] = 0$, $Cov[\xi_t, x_{1l_1,it}] = 0$,

$Cov[\varepsilon_{it}, w_{1m_1,it}] = 0$, $Cov[\xi_t, w_{1m_1,it}] = 0$;

$Cov[\varepsilon_{it}, x_{2l_2,it}] \neq 0$, $Cov[\xi_t, x_{2l_2,it}] \neq 0$,

$Cov[\varepsilon_{it}, w_{2m_2,it}] \neq 0$, $Cov[\xi_t, w_{2m_2,it}] \neq 0$;

$$Cov[\varepsilon_{it}, \varepsilon_{js}] = \begin{cases} \sigma_\varepsilon^2, & i = j, \quad t = s \\ 0, & otherwise \end{cases}$$

$\varepsilon_{it} \sim N(0, \sigma_\varepsilon^2)$

$i, j = 1,2,...,n \quad l_r = 1,2,...,k_r$

$m_r = 1,2,...,q_r \quad (r = 1,2) \quad t,s = 1,2,...,T$.

The model utilizes indicator designations introduced in Table 2:

$x_{11} = Size$, $x_{12} = ROA$, $x_{13} = EA$, $x_{14} = REA$,

$x_{15} = WCA$, $x_{16} = DC$, $k_1 = 6$;

$w_{11} = CA$, $w_{12} = GGD$, $w_{13} = Sov\_Rtg$,

$w_{14} = Sov\_Rtg_{t-1}$, $q_1 = 4$;

$w_{21} = Sov\_Rtg$, $q_2 = 1$.

As in paper [28], we presumed that the model has no endogenous regressors apart from *Sov_Rtg*.

The model was evaluated by means of the generalized method of moments (GMM), accompanied by the adjustment of the covariance matrix of parameter estimates using the Huber-White method [46; 47]. Model adequacy was verified on the basis of the statistical significance of the model as a whole and by means of testing regression residuals for compliance with the normal law of distribution.

The dynamic model is assessed by panel data and provides an opportunity to trace the dynamics of the dependent variable along with accounting for the individual effect α_i. Its specification is as follows (model 3):

$y_{it} = \xi_i + x_{it}\beta + \gamma y_{it-1} + \varepsilon_{it}$,

where $|\gamma| < 1$; ξ_i is the individual effect of i company; $x_{it} = (x_{1,it},...,x_{k,it})$ – vector of exogenous variables; $y_{i,t-1}$ – lag of endogenous variable; β and γ – regression coefficient vectors; ε_{it} – residuals.

$Cov[\varepsilon_{it}, \xi_i] = 0$, $Cov[\varepsilon_{it}, x_{l,js}] = 0$, $Cov[y_{i,t-1}, \xi_i] \neq 0$

$\varepsilon_{it} \sim N(0, \sigma_\varepsilon^2)$

$i = 1,2,...,n \quad l = 1,2,...,k \quad t,s = 1,2,...,T$.

The model utilizes indicator designations introduced in Table 2:

$y_{1,t-1} = Cor\_Rtg_{t-1}$, $x_1 = Sov\_Rtg$, $x_2 = GGD$,

$x_3 = FB$, $k = 3$.

The model was evaluated by means of the generalized method of moments (GMM) applying the Arellano-Bond approach [49]. The $WCA_{i,t-2}$ variable was selected as an instrument along with dependent variable lags. Model adequacy was verified on the basis of the statistical significance of the model as a whole and by means of testing regression residuals for absence of autocorrelation and for compliance with the normal law of distribution. We applied the Sargan-Hansen test for over-identifying restrictions.

We also considered an over-identifying system of regression equations (model 4):

$$\begin{cases} y_{1,it} = y_{2,it}\gamma_1 + x_{1,it}\beta_1 + \varepsilon_{1,it}, \\ y_{2,it} = y_{1,it}\gamma_2 + x_{2,it}\beta_2 + \varepsilon_{2,it} \end{cases}$$

where $y_{1,it}$, $y_{2,it}$ are endogenous variables;

$x_{1,it} = (x_{11,it},...,x_{1k_1,it})$ and $x_{2,it} = (x_{21,it},...,x_{2k_2,it})$

– vectors of predetermined variables; γ_1, γ_2, β_1 и β_2 – regression coefficient vectors; $\varepsilon_{1,it}$ and $\varepsilon_{2,it}$ – residuals.

$$E[\varepsilon_{l_r,it} | x_{l_r,js}] = 0, \; Cov[\varepsilon_{r,it}, \varepsilon_{r,js}] = \begin{cases} \sigma_\varepsilon^2, & i = j, \quad t = s \\ 0, & \text{otherwise} \end{cases}$$

$$Cov[\varepsilon_{1,it}, \varepsilon_{2,js}] = \begin{cases} \sigma_{12}^2, & i = j, \quad t = s \\ 0, & \text{otherwise} \end{cases}$$

$i, j = 1,2,...,n \quad l_r = 1,2,...,k_r \quad (r = 1,2) \quad t,s = 1,2,...,T$.

The model utilizes indicator designations introduced in Table 2:

$y_1 = Cor\_Rtg$, $x_{11,t-1} = Sov\_Rtg_{t-1}$, $x_{12} = Size$,

$x_{13} = ROA$, $x_{14} = DC$, $x_{15,t-1} = DC_{t-1}$, $k = 5$;

$y_2 = Sov\_Rtg$, $x_{21} = GGD$, $x_{22} = GDP$, $x_{23} = CA$,

$k = 3$.

The model was evaluated by means of the GMM. Model adequacy was verified on the basis of the statistical significance of the model as a whole and by means of testing regression residuals for compliance with the normal law of distribution. We applied the Sargan-Hansen test for over-identifying restrictions.

The ordered multiple-choice model (model 5) was used as follows.

$$Prob\left[y_{it} = j\right] = Prob\left[c_{j-1} \le y_{it}^* \le c_j\right],$$

$$y_{it}^* = x_{it}\beta + \xi_i + \varepsilon_{it},$$

where j – current corporate rating; y^* – latent variable corresponding to y; c_j – evaluated fixed levels y^*; $x_{it} = (x_{1,it},...,x_{k,it})$ – regressors vector; ξ_i – a random effect of i company; β – regression coefficient vector; ε_{it} – residuals.

$\varepsilon_{it} \sim N(0,1)$, $E[\varepsilon_{it} | x_{l,js}] = 0$, $E[\varepsilon_{it} | \hat{\imath}_i] = 0$,

$E[\xi_i | x_{l,js}] = 0$

$l = 1,2,...,k \quad i = 1,2,...,n \quad t,s = 1,2,...,T \quad j = 1,...,m$.

The model utilizes indicator designations introduced in Table 2:

$y = Cor\_Rtg$, $x_1 = Size$, $x_2 = ROA$, $x_3 = EA$,

$x_4 = REA$, $x_5 = DC$, $x_6 = CA$, $x_7 = FB$, x_8, x_9 –

dummy variables accounting for the sovereign rating[4].

The model was evaluated by the maximum likelihood method accompanied by adjustment of the estimated covariance matrix of parameter estimates by the Huber-White method.

Note that the advantage of models 1-4 over model 5 is their more descriptive and informative interpretation of parameter estimates, because the latter only allows to interpret their signs.

Results

The results of analysis of the evaluated models' quality confirmed that the models were specified and identified in a rather adequate manner, guaranteeing the consistency of parameter estimates and possibility of their interpretation. We will describe some of the analysis results. Testing of the FE model residuals showed a statistically significant (α = 0.05) absence of cross-sectional correlation: the p-value of χ^2-statistics of the Pesaran test amounted to 0.33. The model was selected reasonably after a comparison to the pooled model and the random effects model: the p-value of corresponding χ^2-statistics of the Wald test and Hausman test amounted to 0.001 and 0.005. We used sufficiently valid tools for a GMM assessment of the dynamic model and the simultaneous equations system: p-value of χ^2-statistics of the Sargan-Hansen tests amounted to 0.75 and 0.998 respectively. The dynamic model produced a positive result of the Arellano-Bond test for the absence of autocorrelation of residuals: p-values of its two successive χ^2-statistics equaled 0.046 and 0.82. The fact that all evaluated models are statistically significant when α = 0.05 is common and positive for all models. The fact that the hypothesis of compliance of regression residuals with the normal distribution is rejected at the significance level of α = 0.05 is common and negative for all models. The p-values of χ^2-statistics of Jarque-Bera tests (for one-dimensional models) and Doornik-Hansen tests (for the regression equations system) did not exceed 0.005.

There is a certain stability of estimates for models 1–4 in the transition from one model to another. The results of evaluation of model 5 do not contradict the results of models 1–4 in regard to the signs of coefficients' estimates. Below is a consolidated table of the evaluation results for models 1–5 (Table 3). The Appendix (see Table P4) provides more detailed assessment results for model 4. Table 3 shows a certain ambiguousness of model parameter estimate assessment, which is indicative of estimator bias due to, in particular, the endogeneity problem of certain regressors, including the sovereign rating. However, the intersection of 95% confidence intervals of these estimates allows to consider these results acceptable. Models 2 and 4 assessed with regard to endogeneity of the sovereign rating are more effective in comparison to models 1 and 3, which do not take endogeneity into account. Model 2 has more statistically significant estimates of parameters as compared to models 1, 3, 4, and is more informative than model 5. Therefore, the informative interpretation of analysis results is stated further, mainly based on model 2 estimates. Let us also note that the option of tracing corporate rating instability over time is an advantage of this model. So, it was demonstrated that the "2016 effect" (ξ_{2016}), which corresponds to a significant decrease of the sovereign rating (by two positions, up to BB-) that year did not manifest itself in a statistically significant way (0.05) in the formation of the corporate rating.

The suggested hypotheses about the vector of influence of the indicators in question on the credit rating level in Russia were partially confirmed. The hypothesis of a positive correlational relationship between the sovereign and corporate ratings is not rejected at the 5% level for all models. A direct dependence between the sovereign and corporate ratings is observed: a decrease of the

[4] The number of slack variables was determined on the basis of ranking of the sovereign rating in the sample, namely, its values of 1, 2, 4 were taken into consideration.

country credit rating by one position results in an almost equal decrease of corporate creditworthiness, which is economically significant if the transition is made from a "junk" grade to an investment grade and vice versa. The economic significance of this change is due to the fact that, first, a company's credit rating influences its access to the capital market including, among other things, the bond market, by determining whether institutional investors (banks, pension funds) are allowed to invest in this company's securities. Second, credit ratings influence capital requirements for banks and insurance companies when they decide to invest in certain companies. Third, a decrease in the corporate rating may cause violations of covenants, growth of interest rates on loans and coupon payments, result in bond buy-out and influence relations with customers and business operations, including a company's ability to conclude and maintain long-term contracts.

Table 3. Consolidated results of assessment of models

Variable	Designations	Coefficient				
		Model 1	Model 2	Model 3	Model 4	Model 5
Company size	*Size*	**1.275***** (0.256)	**–0.412***** (0.060)	–	**0.053*** (0.030)	**–0.856***** (0.269)
Return on assets	*ROA*	**0.008***** (0.003)	**0.004***** (0.001)	–	**0.037** (0.027)	**0.004** (0.004)
Equity capital / gross assets	*EA*	–	**–0.008***** (0.002)	–	–	**–0.162***** (0.005)
Retained profits (loss) / gross assets	*REA*	–	**0.004**** (0.002)	–	–	**0.020*** (0.012)
Net working capital / gross assets	*WCA*	–	**0.010***** (0.004)	–	–	–
EBIT / interest payable	*DC*	**–0.001***** (0.0002)	**–0.0005***** (0.0001)	–	**–0.003** (0.002)	**–0.0006*** (0.00003)
Corporate rating	*Cor_Rtg*	–	–	–	**0.067**** (0.034)	–
Corporate rating (1st lag)	–	–	–	**0.485***** (0.125)	–	–
Current account	*CA*	–	**0.635***** (0.056)	–	**–0.319***** (0.005)	**0.083** (0.057)
Gross public debt	*GGD*	–	**0.490***** (0.065)	**1.049*** (0.561)	**0.552***** (0.017)	–
GDP per capita	*GDP*	–	–	–	**–0.210***** (0.010)	–
Sovereign rating	*Sov_Rtg*	**0.118***** (0.016)	**0.821***** (0.061)	**0.253**** (0.104)	**0.691**** (0.409)	–
Sovereign rating (1st lag)	–	–	**0.824***** (0.074)	–	**0.525** (0.340)	–
Fiscal balance	*FB*	–	–	**0.345*** (0.179)	–	**0.216** (0.143)
Dummy variable for *Sov _ Rtg* = 2	–	–	–	–	–	**1.156*** (0.595)
Dummy variable for *Sov _ Rtg* = 4	–	–	–	–	–	**1.939**** (0.806)

Note: 1) the table presents regression coefficient estimates; 2) "–" means that a regressor not used in the model; 3) p-value: *10%, **5%, ***1%; 4) robust standard errors are within the brackets.

Similar to previous papers (see, for example, [8; 14; 18; 38; 49]) we found out that company size has a positive effect on its credit risk level: its increase by one unit results in an improvement of its credit rating by one position, which is an economically significant result. The positive effect of the *Size* indicator on the corporate rating level is due to the fact that large companies with more opportunities to maneuver resources are characterized by a higher external (ability to service debt obligations) and internal (assets secured by financing sources) financial stability (including under unfavourable market conditions). Besides, their scale may lead to cost reduction due to function centralization or replication of technology. Function centralization implies elimination of certain functions at the local level and their integration in a unified center, which results in uniformity and synergy of the corporate system, elimination of duplicate functions and reduction in operating expenditures. Note that in practice centralization procedures may be cost-ineffective if all project implementation expenses are calculated. Technology replication consists in formalizing the company's technology (for example, sales, accounting or corporate training technology) with its subsequent replication for all corporate subdivisions. Success of replication projects depends on the quality of technology. Nevertheless, the assertion that mass implementation of standard technology has a positive effect on the quality of the finished product is controversial. Advantages of reducing marginal fixed costs and decreasing long-term average costs while the company grows seem obvious, however, a range of restrictions related to the sluggishness of cumbersome systems and increase in transaction costs should be taken into consideration. However, further company expansion may in fact bring about a deterioration in financial and business operations' performance, and consequently, a decrease in its credit rating. The reasons for diminishing returns as a function of size in large companies are as follows [50]: 1) loss of the necessary control over implementation of management decisions; 2) increased costs for the transfer, processing and storage of information; 3) reduced effectiveness of interaction between subdivisions; 4) local interests. Thus, the structure of small and medium companies is more flexible and adaptable to the changing market situation, which ensures their competitiveness.

According to the analysis results, the *CA* indicator, with net export as the main component, has a negative influence on the corporate credit rating. As a rule, an increase in raw materials export contributes to the growth of exporting companies' income, and an improvement of their creditworthiness and solvency. However, export that exceeds the optimum level causes market flooding, a drop in prices of natural resources, and consequently, impaired company ratings due to the deterioration of financial soundness. The current account is affected by the amount of exported natural resources as well as by their global prices. The rise in global prices of raw materials leads to the growth of exporting companies' income, and hence, tax receipts, including the state budget, which has a positive influence on corporate and sovereign creditworthiness. It should be noted that, as a rule, growing income does not instantly result in an increase of the internal expenses of exporting companies, or the government (partly because their amount is defined by a budget adopted beforehand). From the macroeconomic point of view, an increase in expenses immediately following a rise in prices is even undesirable because it may upset the balance between the aggregate demand and supply, and trigger a rise in the inflation rate. An increase in prices of natural resources also has a positive impact on the creditworthiness of exporting companies due to the growth of the nominal exchange rate, which increases the balance of the current account and improves the total trade balance. However, the rise in prices of energy resources triggers a rise in the overall price level in a country, thus increasing manufacturing costs, slowing down economic growth rate and decreasing the aggregate income, and consequently, bringing about a deterioration of the corporate sector's financial stability.

In contrast to the results of previous studies [8; 28] we detected a negative influence of *ROA*, whose growth by 100 basis points (b.p.)[5] results in a decrease of the corporate credit rating by 0.4 b.p. on average. Note that such a small contribution of each financial coefficient to the corporate credit rating is acceptable because agencies use numerous indicators of financial and business operations when assigning ratings. The obtained result is related to the special structural characteristics of the Russian raw materials market. The market of extraction and processing of energy and other natural resources is oligopolistic. The Russian raw materials market is an example of a special form of oligopoly – "fair play," which implies a compromise between an uncoordinated oligopoly and a direct collusion. Companies may not have formal agreements with each other, but act according to certain informal rules. On the one hand, this policy helps to avoid legal liability arising out of the anticartel legislation; on the other – to mitigate the risk of competitors' unpredictable response. The most frequent maneuver in "fair play" is price leadership. In fact, the price leader single-handedly defines the prices (hence, the production volume) for resources that are copied by other companies with slight modifications. The price level is determined in a way that is economically advantageous to all participants of the oligopolistic structure. Therefore, the leader often "probes" the competitors' disposition when making public declarations on the extent of upcoming changes and examines the response of other companies. Moreover, the sanctions imposed in 2014 brought back the government support for raw materials and primary processing product markets, thus strengthening each company's strictly defined concentration [51]. Disruption of balance in one company's oligopolistic structure leads to a deterioration of the general financial stability.

Expectations of a positive influence of *REA* and *WCA* on the credit rating in the private sector were not confirmed.

[5] Basis point is understood as one hundredth of percent.

Ambiguity of interpretation of REA's influence, which characterizes the share of assets financed from retained profits is related to the dependence of its optimum value on the stage of the corporate life cycle. As a rule, *REA* is greater for young companies, which are attractive for investors due to a quick rise in the price of their equity instruments. At the mature stage, company growth slows down; the need for accumulated profit is reduced and, therefore, it is more prone to the distribution of the obtained profit among investors in the form of dividends [52]. An excessive growth of *REA* due to the most flexible part of the indicator – the retained profit – is indicative of the unwillingness of a mature company to "share profits". Investors' interest decreases, resulting in their withdrawal from the corporate sector's capital, consequently, the company's credit quality degrades. The studied sample comprises companies with a long history of financial and business operations. This explains the obtained result.

The controversial nature of *WCA's* influence is related to the "cost-effectiveness – liquidity" problem, which implies the company's striving to combine dynamic development and high solvency [53]. Paper [54], which used the data from Russian capital-intensive telecommunication, power-generating and iron and steel companies revealed an inverse correlation between liquidity and cost-effectiveness indicators. The conclusion that *WCA* growth as a liquidity indicator may damage corporate credit rating is due to the need to prolong the financial cycle[6] (to maintain the optimum liquidity level), on the one hand, and to shorten it (to improve cost-effectiveness), on the other hand [55–57]. A *WCA* increase of 100 b.p. decreases the corporate credit rating by 1 b.p. on average, which is two times larger than the effect of growth of *ROA* and *REA,* whose contribution to the formation of the corporate credit rating is virtually the same.

A positive influence of *EA* and *DC* [8], which characterize the level of a company's financial independence and its ability to generate positive cash flows sufficient to cover short-term financial obligations was expected. The result may be explained by the fact that the financial effect of use of borrowed funds manifests in an increased return on assets of the private sector because it reduces its default risk. However, in fact, this conclusion is not always correct. When financial leverage increases significantly, a substantial slowdown of its positive effect takes place, i.e. from a certain moment on there is no point in increasing borrowed capital and its servicing [58]. Note that a positive contribution of the *DC* factor to the corporate creditworthiness level is not economically significant and amounts to 0.05 b.p. This result may mean that a company's ability to service long-term financial obligations is more important in the formation of its credit rating than its ability to service short-term obligations. The ability to pay off long-term debts depends not just on a company's financial and business performance, but also on macroeconomic factors, which significantly raise the level of uncertainty related to timely and full payments of the debt.

One of the main factors that define the systemic risk is the total national debt load, which, when increased, undermines companies' financial stability, hence impairing their credit estimates. A negative effect may be observed due to capital outflow from the country and reduction in foreign direct investment caused by the growing budget deficit or increased taxation required for the timely servicing of national financial obligations. The negative influence of FB on corporate creditworthiness indicates that a significant part of the national budget's income base is made up of taxes paid by legal entities.

The contribution of macroeconomic environment factors to the corporate creditworthiness level is more significant in comparison to the contribution of idiosyncratic risk indicators. Apart from GDP per capita, a 100-b.p. change in each country risk indicator results in the change of the corporate credit rating by an economically significant value: on average by approximately 60–80 b.p.

According to analysis results, corporate credit rating has a "short memory" because estimates of lag coefficients *Cor_Rtg* turned out to be statistically insignificant ($\alpha = 0.05$) starting from the second order inclusively. Consequently, only the previous year's rating influences the current credit rating value. This result confirms the practice of assigning corporate credit ratings, according to which the current year's corporate credit rating is formed with regard to the corporate and sovereign ratings of the previous and current year respectively [12; 13].

Conclusion

Based on the data of Russian companies we have studied the determinants of their credit risk with regard to the sovereign rating. A statistically significant direct influence of the sovereign rating on the corporate rating was demonstrated. A positive effect of financial independence and company size indicators on the corporate creditworthiness level was revealed. In contrast to similar foreign and Russian studies, a negative influence of certain cost-effectiveness and liquidity indicators and export-import government activity indicators was determined. This result is primarily related to the specifics of the Russian raw material market structure and to the special features of financial and business operations in the national and global markets of extraction and processing of raw materials and other natural resources. We confirmed that the corporate credit risk level was determined by a company's fundamental financial indicators, as well as by the macroeconomic environment in which it operates. It was also discovered that the "short memory" feature is characteristic of the corporate credit rating because its current level is defined only by the previous year's value. The results of the present research are partially in line with the results of papers [8; 28; 20; 36–38].

[6] FC = ITP + ARP – APP, where FC – financial cycle; ITP – inventory turnover period; ARP – accounts receivable turnover period; APP – accounts payable turnover period.

They are independently valuable because they demonstrate the specific character of credit rating formation for Russian companies from a certain sector, specifically – the raw materials sector.

Research papers dedicated to the influence of the sovereign rating on corporate credit rating are of great importance for the improvement of Russian companies' investment attractiveness. Further research of this topic requires a study of both quantitative and qualitative factors that determine corporate and sovereign credit risks. The sample needs to be expanded in order to obtain more accurate results and to extend the range of examined sectors that may respond to the changes in the country credit rating in different ways. Moreover, the direct influence of the fluctuations of the sovereign credit rating on the corporate financial and investment policy also requires further research.

References

1. Karminsky A.M., Polozov A.A. Encyclopedia of ratings: Economics, society, sport. Moscow: Forum; 2016. 448 p. (In Russ.).
2. Huhne C. How the rating agencies blew it on Korea. *The International Economy*. 1998;(12):46-63.
3. Ferri G., Liu L.-G., Stiglitz J.E. The procyclical role of rating Agencies: Evidence from the East Asian crisis. *Economic Notes*. 1999;28(3):335–355. https://doi.org/10.1111/1468-0300.00016
4. Reisen H., von Maltzan J. Boom and bust and sovereign ratings. *International Finance*. 1999;2(2):273-293. https://doi.org/10.1111/1468-2362.00028
5. Reisen H. Ratings since the Asian crisis. OECD Development Centre Working Paper. 2003;(214). https://doi.org/10.1787/746001826505
6. Rigobon R. Contagion: How to measure it? NBER Working Paper. 2001;(8118). https://doi.org/10.3386/w8118
7. Standard_and_Poors_Все_что_нужно_знать_о_рейтингах.pdf (mos.ru)
8. Borensztein E., Cowan K., Valenzuela P. Sovereign ceilings "lite"? The impact of sovereign ratings on corporate ratings. *Journal of Banking & Finance*. 2013;37(11):4014-4024. https://doi.org/10.1016/j.jbankfin.2013.07.006
9. Standard & Poor's. 1997. Less credit risk for borrowers in dollarized economies. Credit Week. New York: Standard and Poor's, April 30
10. Varma P. Sovereign bond defaults, rating transitions, and recoveries (1985-2002). Special Comment. New York: Moody's; 2003. 24 p. URL: https://www.iiiglobal.org/sites/default/files/Sovereign_Bond_Defaults_Levey%283%29.pdf
11. Corporate and government ratings that exceed the sovereign rating. Standard and Poor's. Dec. 18, 2012. URL: https://www.spglobal.com/ratings/en/research/articles/200507-corporate-and-government-ratings-that-exceed-the-sovereign-rating-7647208
12. Standard & Poor's. (2014). Sovereign Rating Methodology. Standard and Poor's, 23 December.
13. Sovereign-Rating-Methodology.pdf (enterprise.press)
14. Sovereign rating methodology. Standard and Poor's. Oct. 12, 2017.
15. S&P кредитные рейтинги КНИГА.pdf (hse.ru)
16. Durbin E., Ng D. The sovereign ceiling and emerging market corporate bond spreads. *Journal of International Money and Finance*. 2005;24(4):631-649. https://doi.org/10.1016/j.jimonfin.2005.03.005
17. Peter M., Grandes M. How important is sovereign risk in determining corporate default premia? The case of South Africa. IMF Working Paper. 2005;(217). URL: https://www.imf.org/external/pubs/ft/wp/2005/wp05217.pdf
18. Ferri G., Liu L.-G., Majnoni G. The role of rating agency assessments in less developed countries: Impact of the proposed Basel guidelines. *Journal of Banking & Finance*. 2001;25(1):115-148. https://doi.org/10.1016/S0378-4266(00)00119-9
19. Ferri G., Liu L.-G. Do global credit rating agencies think globally? The information content of firm ratings around the world. 2002. URL: http://repec.org/res2002/Ferri.pdf
20. Mohapatra S., Nose M., Ratha D. Impacts of sovereign creditworthiness on sub-sovereign debt ratings in emerging and developing economies. Policy Research Working Paper. 2016;(7618). URL: https://openknowledge.worldbank.org/bitstream/handle/10986/24160/Impacts0of0sov0developing0economies.pdf?sequence=5&isAllowed=y
21. Packer F. Credit ratings and the Japanese corporate bond market. In: Levich R.M., Majnoni G., Reinhart C.M., eds. Ratings, rating agencies and the global financial system. Boston, MA: Springer-Verlag; 2002:139-158. (The New York University Salomon Center Series on Financial Markets and Institutions. Vol. 9). https://doi.org/10.1007/978-1-4615-0999-8_9
22. Cantor R., Packer F. Determinants and impact of sovereign credit ratings. *Economic Policy Review*. 1996;2(2):37-54. URL: https://www.newyorkfed.org/medialibrary/media/research/epr/96v02n2/9610cant.pdf
23. Kisgen D.J., Strahan P.E. Do regulations based on credit ratings affect a firm's cost of capital? *The Review of Financial Studies*. 2010;23(12):4324-4347. https://doi.org/10.1093/rfs/hhq077

24. Baghai R.P., Servaes H., Tamayo A. Have rating agencies become more conservative? Implications for capital structure and debt pricing. *The Journal of Finance*. 2014;69(5):1961-2005. https://doi.org/10.1111/jofi.12153

25. Sufi A. The real effects of debt certification: Evidence from the introduction of bank loan ratings. *The Review of Financial Studies*. 2009;22(4):1659-1691. https://doi.org/10.1093/rfs/hhm061

26. Tang T.T. Information asymmetry and firms' credit market access: Evidence from Moody's credit rating format refinement. *Journal of Financial Economics*. 2009;93(2):325-351. https://doi.org/10.1016/j.jfineco.2008.07.007

27. Lemmon M., Roberts M.R. The response of corporate financing and investment to changes in the supply of credit. *Journal of Financial and Quantitative Analysis*. 2010;45(3):555-587. https://doi.org/10.1017/S0022109010000256

28. Chernenko S., Sunderam A. The real consequences of market segmentation. *The Review of Financial Studies*. 2012;25(7):2041-2069. https://doi.org/10.1093/rfs/hhr143

29. Harford J., Uysal V.B. Bond market access and investment. *Journal of Financial Economics*. 2014;112(2):147-163. https://doi.org/10.1016/j.jfineco.2014.01.001

30. Almeida H., Cunha I., Ferreira M.A., Restrepo F. The real effects of credit ratings: The sovereign ceiling channel. *The Journal of Finance*. 2017;72(1):249-290. https://doi.org/10.1111/jofi.12434

31. Graham J., Leary M.T., Roberts M.R. How does government borrowing affect corporate financing and investment? NBER Working Paper. 2014;(20581). https://doi.org/10.3386/w20581

32. Kisgen D.J. Do firms target credit ratings or leverage levels? *Journal of Financial and Quantitative Analysis*. 2009;44(6):1323-1344. https://doi.org/10.1017/S002210900999041X

33. Multiple Equilibria, Contagion, and the Emerging Market Crises - WP/99/164 (imf.org)

34. Lewis M. Boomerang: Travels in the New Third World. New York: W.W. Norton & Company; 2012. 240 p.

35. Amato J.D., Furfine C.H. Are credit ratings procyclical? BIS Working Paper. 2003;(129). URL: https://www.bis.org/publ/work129.pdf

36. COVID-19 pandemic: Financial stability implications and policy measures taken. Basel: Financial Stability Board; 2020. 14 p. URL: https://www.fsb.org/wp-content/uploads/P150420.pdf

37. Karminsky A.M. Ranking models for industrial companies. *Upravlenie finansovymi riskami = Financial Risk Management Journal*. 2009;(3):228-243. (In Russ.).

38. Karminsky A.M. Corporate rating models for emerging markets. *Korporativnye finansy = Journal of Corporate Finance Research*. 2011;5(3):19-29. (In Russ.). https://doi.org/10.17323/j.jcfr.2073-0438.5.3.2011.19-29

39. Karminsly A.M., Kiselev V.Yu., Kolesnichenko A.S. Models of sovereign ratings and their possibilities. *Finansovaya analitika: problemy i resheniya = Financial Analytics: Science and Experience*. 2011;(41):2-12. (In Russ.).

40. Karminsky A.M. The synergy of rating agencies' efforts: Russian experience. In: Bera A., Ivliev S., Lillo F., eds. Financial econometrics and empirical market microstructure. Cham: Springer-Verlag; 2015:93-109. https://doi.org/10.1007/978-3-319-09946-0_8

41. Kuchiev A.Z., Kuchieva I.H. Organization and credit rating methods for corporate customers applicable. *Terra Economicus*. 2013;11(3-3):65-68. (In Russ.).

42. Karminsky A., Peresetsky A. Models of banks ratings. *Prikladnaya ekonometrika = Applied Econometrics*. 2007;(1):3-19. (In Russ.).

43. Wilson R.S., Fabozzi F.J. Corporate bonds: Structure and analysis. New York: John Wiley & Sons; 1996. 384 p.

44. Karminsky A.M., Petrov A.E. Dynamic financial stability ratings for banks and SMEs. *Kontrolling = Controlling*. 2004;(3):26-39. (In Russ.).

45. Hausman J.A., Taylor W.E. Panel data and unobservable individual effects. *Journal of Econometrics*. 1981;16(1):155. https://doi.org/10.1016/0304-4076(81)90085-3

46. Diggle P.J., Heagerty P., Liang K.-Y., Zeger S.L. Analysis of longitudinal data. Oxford: Oxford University Press; 2002. 379 p. https://doi.org/10.1002/sim.1701

47. Beck N., Katz J.N. What to do (and not to do) with time-series cross-section data. *American Political Science Review*. 1995;89(3):634-647. https://doi.org/10.2307/2082979

48. Huber P.J. The behavior of maximum likelihood estimates under non-standard conditions. In: Le Cam L.M., Neyman J., eds. Proc. 5th Berkeley symp. on mathematical statistics and probability. Vol. 1: Statistics. Berkeley, CA: University of California Press; 1967:221-233.

49. White H. A heteroskedasticity-consistent covariance matrix estimator and a direct test for heteroskedasticity. *Econometrica*. 1980;48(4):817-838. https://doi.org/10.2307/1912934

50. Arellano M., Bond S. Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations. *The Review of Economic Studies*. 1991;58(2):277-297. https://doi.org/10.2307/2297968

51. Cavallo E.A., Valenzuela P. The determinants of corporate risk in emerging markets: An option-adjusted spread analysis. *International Journal of Finance & Economics*. 2010;15(1):59-74. https://doi.org/10.1002/ijfe.398

52. Shchurina S.V., Mikhailova M.V. Company's financial sustainability: Problems and solutions. *Finansy i kredit = Finance and Credit*. 2016;(42):43-60. (In Russ.).

53. Kazantseva E.G. Development of Russian oligopolistic markets. *Novye tekhnologii = New Technologies*. 2016;(1):73-80. (In Russ.).

54. Baker H.K. Dividends and dividend policy. Hoboken, NJ: John Wiley & Sons, Inc.; 2009. 560 p.

55. Raheman A., Nasr M. Working capital management and profitability: Case of Pakistan firms. *International Review of Business Research Papers*. 2007;3(1):279-300. URL: https://www.researchgate.net/publication/228727444_Working_capital_management_and_profitability-case_of_Pakistani_Firms

56. Garanina T.A., Petrova O.E. Relationship between liquidity, cash conversion cycle and returns of Russian companies. *Korporativnye finansy = Journal of Corporate Finance Research*. 2015;9(1):5-21. (In Russ.). https://doi.org/10.17323/j.jcfr.2073-0438.9.1.2015.5-21

57. Phuong D.H., Su J.-T. The relationship between working capital management and profitability: A Vietnam case. *International Research Journal of Finance and Economics*. 2010;(49):62-71.

58. Bhunia A., Bagachi B., Khamrui B. The impact of liquidity on profitability: A case study of FMCG companies in India. *Research and Social Practices in Social Sciences*. 2012;7(2):44-58.

59. Volkov D.L., Nikulin E.D. Operating efficiency and fundamental value of equity of the organization. *Vestnik Sankt-Peterburgskogo universiteta. Seriya 8: Menedzhment = Vestnik of Saint Petersburg University. Management Series*. 2009;(1):63-92. (In Russ.).

60. Salmin P.S., Salmina N.A. Parametric modelling of leverage effect. *Ekonomicheskii analiz: teoriya i praktika = Economic Analysis: Theory and Practice*. 2014;(27):27-34. (In Russ.).

Appendix

Table P1. List of companies in the sample

Industry	Corporate issuer
Metallurgy	Metalloinvest HC
	Chelyabinsk Pipe-Rolling Plant
	RUSAL Bratsk
	Mining and Metallurgical Company Norilsky Nickel
Oil and gas	Rosneft Oil Company
	Transneft
	Gazprom Neft
	Bashneft
	Gazprom
Chemical industry	Uralkali
	SIBUR Holding
	Mineral and Chemical Company Eurochem
	Akron
Power generating industry	FGC UES
	RusHydro
	Moscow United Electric Grid Company
	AtomEnergoProm
	Interregional Distribution Grid Company Centre
	LenEnergo

Table P2. Result of preliminary analysis of primary data

Group	Indicator	UOM	Mean	Minimum	Maximum	Coefficient of variation, %	Asymmetry	Excess kurtosis
Country risk	Inflation	% per year	7.38	2.90	15.50	60,8	0.89	–0.53
	Real GDP growth	% per year	0.52	–2.3	2.3	303.8	–0.79	–0.56
	Current account	% of GDP	3.72	1.90	6.80	51.1	0.60	–1.27
	Gross public debt	% of GDP	15.74	14.60	16.40	4.07	–0.84	–0.73
	Per capita GDP	PPP, billion US dollars, natural logarithm	25.19	25.17	25.22	0.06	0.35	–1.13
	Fiscal balance	% of GDP	–0.90	–3.20	–0.14	244.4	0.60	–0.92
	Sovereign rating	0 – the best value; 5 – the worst value	2.00	4.00	1.00	55	0.91	–0.50
Individual corporate risk	Company size	billion US dollars, natural logarithm	27.16	24.7	30.39	5.5	0.48	–0.16
	Return on assets	% per year	8.74	–1.00	49.00	133.3	2.48	5.87
	Financial leverage	% per year	13.79	–59.00	75.00	313	–0.13	–1.21
	Equity capital / gross assets	% per year	96.95	25.00	245.00	56.7	0.86	0.78
	Current liquidity	% per year	178.23	23.00	763.00	108	1.83	2.69
	EBIT / interest payable	% per year	479.13	–52.00	1680.00	114.6	0.73	–0.72
	Retained profits (loss) / gross assets	% per year	25.79	7.00	70.00	66.15	1.25	0.73
	Net working capital / gross assets	% per year	25.84	4.00	65.00	62	0.71	–0.15
	Corporate rating	0 – the best value; 5 – the worst value	2.21	5.00	0.00	57.7	0.42	–1.45

Table P3. Pearson paired correlation coefficients

	Size	ROA	LEV	EA	QR	REA	WCA	DC	INFL	GDP_gr	CA	GGD	GDP	FB
Size	1													
ROA	-0.18	1												
LEV	-0.15	0.04	1											
EA	0.24	-0.06	-0.61	1										
QR	0.18	-0.07	-0.41	0.26	1									
REA	-0.02	0.08	-0.41	0.28	0.16	1								
WCA	-0.12	-0.03	0.41	-0.15	0.12	0.04	1							
DC	-0.07	-0.01	-0.17	-0.02	0.31	0.12	-0.15	1						
INFL	-0.04	-0.09	0.06	-0.02	-0.04	-0.08	0.07	-0.04	1					
GDP _gr	0.03	0.07	-0.06	0.02	0.01	0.08	-0.05	0.04	-0.98	1				
CA	0.03	-0.11	-0.02	0.05	0.06	0.01	-0.01	0.01	0.07	0.02	1			
GGD	-0.05	-0.01	0.07	-0.05	-0.03	-0.08	0.07	-0.04	0.79	-0.83	-0.42	1		
GDP	0.03	-0.02	-0.05	0.03	0.05	0.06	-0.02	0.03	-0.75	0.84	0.41	-0.39	1	
FB	0.03	-0.06	-0.05	0.04	0.04	0.06	-0.02	0.02	-0.66	0.76	0.59	-0.43	0.97	1

Table P4. Results of evaluation of the simultaneous equations system

Equation	Variables		Coefficients
(1)	Endogenous	Corporate rating	
	Predetermined	Company size	0.053* (0.030)
		Return on assets	0.037 (0.027)
		EBIT / interest payable	-0.003 (0.002)
		Sovereign rating	0.691* (0.409)
		Sovereign rating (1st lag)	0.525 (0.340)
		EBIT / interest payable (1st lag)	0.005 (0.003)
(2)	Endogenous	Sovereign rating	
	Predetermined	Gross public debt	0.552*** (0.017)
		Per capita GDP	-0.210*** (0.010)
		Current account	-0.319*** (0.005)
		Corporate rating	0.067** (0.034)
Test			P-value
Wald test			<0.0001
Sargan test			0.998
Doornik-Hansen test			<0.0001

Note: (1) the table presents assessments of the regression coefficient; (2) p-value: *10%, **5%, ***1%; (3) robust standard errors are within the brackets.

Contribution of the authors: the authors contributed equally to this article.

The authors declare no conflicts of interests.

The article **was submitted** 06.01.2022; **approved after reviewing** 08.02.2022; **accepted for publication** 14.03.2022.

DOI: https://doi.org/10.17323/j.jcfr.2073-0438.16.1.2022.83-98
JEL classification: G32, C10, D80, O16

Accounting for ESG Risks in the Discount Rate for Business Valuation

Dmitry Zakhmatov ✉
Ph.D. in Economics, Associate Professor, Higher School of Business of Kazan Federal University, Kazan, Russia, z_dmitry@bk.ru, ORCID

Venera Vagizova
Dr. of Economics, Professor, Higher School of Business of the Kazan Federal University, Kazan, Russia, venera.vagizova@mail.ru, ORCID

Gayaz Valitov
Intern, NAO Euroexpert, Valuation and Cost Consulting Department, Moscow, Russia, valitov2001@gmail.com, ORCID

Abstract

The research is aimed at developing tools for determining and justifying specific ESG risks for the purpose of accounting for projected cash flows in the discount rate in business valuation. A study of modern methods, standards and publications in this area has been conducted, and the need for their refinement and development for practical use has been determined.

The research used the results of the works by foreign and domestic authors, as well as their own professional experience. The authors used general scientific methods of cognition, such as classification, logical and system analysis, typology and generalization.

The proposed tools are aimed at substantiating, supplementing and clarifying the discount rate model (CAPM) by introducing additional coefficients that take into account the influence of ESG factors. The article proposes a scoring model for assessing risks on a point scale and tools for their subsequent translation into correction coefficients using the method of expert assessments, which already allow them to be applied in practice today. The model of accounting for specific risks is based on data from literary sources, and demonstrated using a practical example.

The author's tool is designed to provide analysts, appraisers and experts with a qualitative justification and calculation of specific risks associated with ESG factors when evaluating a business. It is also assumed that the proposed tools will serve as one of the criteria for managing business value, allowing for measures to reduce specific risks and increase company capitalization.

Keywords: ESG risks, business valuation, principles of sustainable development, risk accounting in business evaluation, specific risks, unsystematic risks, development of business evaluating methodology

For citation: Zakhmatov, D., Vagizova, V. and Valitov, G. Accounting for ESG risks in the discount rate for business valuation. *Journal of Corporate Finance Research.* 2022;16(1): 83-98. https://doi.org/10.17323/j.jcfr.2073-0438.16.1.2022.83-98

Introduction

Environmental, Social, and Corporate Governance (ESG) is an evaluation of a firm's collective conscientiousness in regard to social and environmental factors. It is typically a score that is compiled from data collected on specific metrics related to intangible assets within the enterprise. It could be considered a form of corporate social credit score. These three broad categories are used to define "socially responsible investors", i.e. the investors who consider it important to incorporate their values and concerns (such as environmental, governance, or community concerns) and then make an investment decision, rather than considering solely the potential profitability.

Today, the vast majority of companies pay attention to the most evident value creation factors: income, cost components, capital raising costs and others. At the same time, company management associates their value with the concept of sustainable development and related factors. The reason for this is the relationship between a number of sustainable development factors and key factors of a company's value and financial results. Thus, the issue of assessing the value of a business with regard to sustainable development factors becomes very relevant. Integrated reporting could best explain to users of financial statements the impact of factors of a company's activities on its market value [1–3].

In the comparative method of determining the business value of an ESG enterprise, these factors influence the valuation multipliers [4–6]. In the revenue method of determining the value of a business, these factors affect the components of the company's cash flows: revenue, costs, and capital investments [7]. Both research works and analysis within the framework of companies' development plans are devoted to these issues. At the same time, insufficient attention is paid to the definition and justification of the components of specific risks taken into account in the discount rate of projected cash flows. It was this aspect that the authors found interesting and set out to investigate.

This article discusses the proposals for the development of a business valuation methodology from the viewpoint of examining ESG factors when building a discount rate model for business valuation. The reports of analysts and appraisers either indicate subjective assessments of a company's specific (non-systematic) risks, or they are disregarded.

This article also discusses the advantages and limitations of existing approaches to assessing the premium for specific risks and suggests approaches to assessing the premium for specific risks with regard to ESG factors.

Hypothesis

The hypothesis set forth by the authors states that accounting for ESG factors when determining specific risks in the calculation of the discount rate increases the validity and reliability of business valuation

Results

As a result of analyzing the specific risk factors of an enterprise taken into account when designing the discount rate model and the classification of external social and environmental factors, it is advisable to detect the following factors:

- risks related to the quality of corporate governance
- stability risks and profit predictability
- risks associated with key personnel

The question arises as to the source of analytical data on these factors that allows them to be taken into account in enterprise value estimation models. The traditional financial reporting model does not currently satisfy investors and other interested users to a sufficient degree, and is increasingly being criticized for containing only economic indicators and relying on the already accomplished facts of economic activity. In this regard, an additional and important factor that must be taken into account when assessing the value of a business is the availability and content of its non-financial statements.

In many ways, non-financial reporting should be taken as seriously as financial reporting. These types of reporting complement each other, allowing stakeholders to get a comprehensive objective view of the organization.

To define non-financial reporting, the Association of Managers uses the term "corporate social report", which means "a public tool for informing shareholders, employees, partners and the whole society about how and at what pace the company implements the goals of economic sustainability, social well-being and environmental stability laid down in its mission or strategic development plans". A similar definition of the corporate sustainability report is provided by the Association of Chartered Chief Accountants (CGA – Canada). The Russian Social Information Agency uses the term |social report", which refers to a document describing the assessment of the company's public influence [8; 9].

Non-financial reporting standards guarantee a certain quality of a non-financial report, as they were developed and approved by expert groups that have identified the most significant aspects of the activities of organizations subject to public disclosure. However, certain experts in the field of corporate social responsibility express skepticism about these standards, since even their use does not prevent the so–called green conspiracy – an insincere demonstration of commitment to these principles.

The next aspect in accounting for these factors concerns their use directly in calculations, in particular, when designing the discount rate model.

Additional tools for incorporating these factors can be proposed in the development of the business assessment methodology, allowing the use of most of the methods mentioned in specialized literature, some of which are systematized in Table 2.

The authors propose to analyze ESG factors with a ranking of the impact on a particular indicator of specific risk.

Risks related to the quality of corporate governance

Analytical reviews submitted by the Russian Union of Industrialists and Entrepreneurs state that a non-financial report is a portrait of a company reflecting its public facade [10]. It allows to see what the company's strategy is, what it does to implement it, what results it achieves and at what price.

The reporting information provided characterizes the stability and reliability of the company. The very fact of submitting the report to the public indicates that the company is moving towards increasing information openness and transparent activities, is responsible for the costs of achieving results, is ready to engage in dialogue and cooperate with interested parties. Another important and relevant task is to further improve the quality of information disclosed by companies as a vital factor in building trust and reputation.

In practice, the following types of reporting have become widespread today: corporate social, sustainable development, socio-ecological and social. They disclose such company data as the number of jobs, average wages, the number of women in senior positions, methods of combating corruption, negative impact on the environment, etc. This suggests that the practice of non-financial reporting took on a global scale at the turn of the 21st century.

Non-financial company reports typically contain three main sections: economic, social and environmental.

The key principles of sustainable development and responsible business conduct reflected in non-financial reporting are:

- Business supports and respects the protection of human rights accepted by the international community;
- Business is sure that it is not involved in human rights violations;
- Business supports the freedom to form associations and recognizes the right to conclude collective agreements;
- Business supports the exclusion of all forms of forced and compulsory labor;
- Business supports the ban on child labor;
- Business supports the elimination of discrimination in hiring and employment;
- Business supports a careful approach to environmental issues;
- Business puts forward initiatives to ensure greater environmental responsibility;
- Business promotes the development and implementation of environmentally friendly technologies;
- Business fights all forms of corruption, including extortion and bribery.

Adherence to the principles of sustainable development and responsible investment contributes to a more effective achievement of companies' strategic goals, as it allows for long-term investments in creating a favorable social environment, while reducing the risks of the institutional and social environment.

Thus, the availability of non-financial reporting and the level of its application is an important indicator characterizing the quality of a company's corporate governance.

The authors propose to determine the impact on risks with regard to:

- applicable standards, platforms and guidelines for the preparation of non-financial reporting;
- the level of development of non-financial reporting in the industry/companies similar in scale of activity (with regard to the indicators of comparable companies, a comparative approach to evaluation).

The most well-known ratings in the field of environment, social sphere and management (ESG) are prepared by the following agencies: KLAR, Sustainalytics, Moody's ESG (Vigeo-Eiris), S&P Global (RobecoSAM), Refinitiv (Asset4) and MSCI [11].

The assessment of the availability factor and the level of its application in assessing the specific risks of a company is provided in Table 1.

Table 1. Availability of non-financial reporting

The analyzed factor	Level of development of the enterprise in question	Current level of development of non-financial reporting in the industry/ companies similar in scale of activity	Impact assessment for the comparative approach	Impact assessment for the revenue approach
Availability of non-financial reporting	Reporting is in place, the GRI application level is advanced (comprehensive) or IIRC full	not developed	maximum positive impact	maximum positive impact
		developed	positive impact	
	Reporting is in place, the GRI application level is basic (core) or IIRC partial	not developed	positive impact	positive impact
		developed	has no effect	
	No reporting is being implemented	not developed	has no effect	negative impact
		developed	negative impact	

Table 2. Availability of an environmental management system according to ISO 14001/ GOST R ISO 14001 or other standards

The analyzed factor	The state of development of the enterprise in question	The current level of development of the environmental management system in the industry/companies similar in scale of activity	Impact assessment for the comparative approach	Impact assessment for the revenue approach
Availability of an environmental management system according to ISO 14001/ GOST R ISO 14001 or other standards	Implemented in the company and/or the main production subsidiaries of the company; quantitative indicators of its effectiveness are reflected in the company's public documents	not developed	maximum positive impact	maximum positive impact
		developed	positive impact	
	Implemented in the company and/or the main production subsidiaries of the company; quantitative indicators of its effectiveness are not reflected in the company's public documents	not developed	positive impact	positive impact
		developed	has no effect	
	Not implemented in the company and/or the main production subsidiaries of the company	not developed	has no effect	negative impact
		developed	negative impact	

Stability risks and profit predictability

Modern conditions dictate new rules of the game to businesses, with a focus on "environmental friendliness". No industrial enterprise can function today without implementing a set of environmental measures. The policy of many states is aimed at "greening" the economy. The environmental component is now an integral part of the business sphere.

Investors understand that the implementation of an environmental management system provides a company with the following advantages:

- systematic reduction of negative impact on the environment;
- systematic reduction of production and operating costs;
- In addition, the introduction of an environmental management system provides a set of additional benefits, including:
- reducing the risks of emergency situations and the scale of consequences in case of their occurrence;
- increasing the competitiveness of the enterprise in foreign and domestic markets;
- the possibility of developing new markets;
- forming a favorable image and improving relations with consumers, partners, investors, government agencies and the public;
- improving investment attractiveness;
- reduction loan interest rates;
- reducing insurance payments.

The above set of additional advantages has a significant impact on the stability and predictability of profit, and the impact of the availability of an environmental management system should be taken into account in the estimates provided in Table 2.

Risks associated with key personnel

Among other things, this factor provides an assessment of social risks in a company's activities and evaluates the company in relation to stakeholders: compliance with the interests of employees, local communities, procurement policy and contractors, as well as respect for human rights and impact on society are considered.

The social policy assessment can be based on a comprehensive analysis of 5 groups of indicators focused on the analysis of key social policy elements in the company's activities:

- working conditions and safety at work – this indicator group comprises occupational injuries over the past three years;
- personnel policy – this group of indicators includes the average salary level in the company, staff turnover and other working conditions;
- social support – employee compensation is assessed in the form of benefits, medical care, pension insurance, etc.;
- human rights and discrimination – company policy and standards in the human rights sphere, as well as gender balance and information openness in regard to these issues are evaluated;
- interaction with local communities – this group of indicators includes charitable activities and social investments in the regions of presence, as well as interaction with the local population.

In assessing social policy, the proposed methodology is based on standards, guidelines and recommendations, including, but not limited to, the following documents:

- The Global Reporting Initiative's Sustainability Reporting Guide [12];
- Gold Standard – Business And The Sustainable Development Goals [13] ;
- Below are the groups of indicators and criteria for evaluating the social indicator block .

An assessment of the impact of risks associated with key personnel on the implementation of social policy, the company can receive from 0 to 5 points.

Further evaluation of the indicator is also proposed to be carried out in terms of correlating the indicators of a particular enterprise with the current level of development of the company's social policy in the industry/companies similar in scale of activity (Table 3).

Table 3. Social policy of the enterprise

The analyzed factor	The state of development of the enterprise in question in points	The current level of development of the company's social policy in the industry/companies similar in scale of activity	Impact assessment for the comparative approach	Impact assessment for the revenue approach
Social policy of the enterprise	0.00–1.75	0–1.75	no impact	negative impact
		2.0–3.25	negative impact	
		3.5–5	maximum negative impact	
	2.00–3.25	0–1.75	positive impact	positive impact
		2.0–3.25	no impact	
		3.5–5	negative impact	
	3.5–5.0	0–1.75	maximum positive impact	maximum positive impact
		2.0–3.25	positive impact	
		3.5–5.0	no impact	

Evaluation of the company's social policy is provided in Table 4.

Table 4. Evaluation of the company's social policy

Elements of social policy	Groups of indicators	Evaluation criteria
Working conditions and safety at work	Accident frequency coefficient	0.5 points – an indicator value lower than the industry average or (in the absence of an industry average) an indicator value close to 0 over the past three years; 0.25 points – an indicator value equal to the industry average or (in the absence of an industry average) an indicator value that shows a downward trend; 0 points – an indicator value is higher than the industry average or (in the absence of an industry average) an indicator value that shows a tendency to deteriorate
	The frequency coefficient of injuries with temporary disability	0.5 points – an indicator value lower than the industry average or (in the absence of an industry average) an indicator value close to 0 over the past three years; 0.25 points – an indicator value equal to the industry average or (in the absence of an industry average) an indicator value that shows a downward trend; 0 points – an indicator value higher than the industry average or (in the absence of an industry average) an indicator value that shows a tendency to deteriorate

Elements of social policy	Groups of indicators	Evaluation criteria
Personnel policy	Availability of personnel development/employee training programs	0.5 points – the company has training/advanced training/ additional education programs for employees and/or subsidized training programs at universities; 0.25 points – personnel training programs are limited to standard qualification courses/instruction; 0 points – there are no employee development and training programs
	Staff turnover rate	0.5 points – staff turnover rate is lower than the industry average; 0.25 points – staff turnover rate at the average industry level; 0 points – staff turnover rate is higher than the industry average
Social support	Availability of financial assistance programs for vulnerable categories of employees/their families	0.5 points – there is a financial assistance program for employees/families of employees (working women and other persons with family responsibilities, young workers, workers in the Far North, combat veterans, participants in the liquidation of the Chernobyl accident and other categories of workers in need of social benefits); 0 points – social benefits in excess of the legal requirements are not provided
	Availability of a voluntary health insurance program (VMI) and other forms of medical care for employees	0.5 points – there is a comprehensive VMI program and the possibility of voluntary medical insurance for family members of employees on preferential corporate terms or own medical infrastructure; 0.25 points – standard VMI program for employees; 0 points – there is no VMI/medical care program for employees
Human rights and discrimination	Availability of a feedback mechanism and/or a helpline on human rights violations, corruption and violations of the Labor Code	0.5 points – there is a hotline/anonymous channel for feedback/complaints on corruption, human rights violations and discrimination for company employees; 0.25 points – there is a feedback/complaints channel, but it is not anonymous; 0 points – there is no feedback/complaint mechanism for company employees
	Requirements for suppliers/contractors in the field of human rights/ ethics of doing business	0.5 points – there is evidence that the company imposes requirements on suppliers/contractors in the field of human rights/ethics of doing business and responsibly treats investment decisions from the point of view of ethics (relevant clauses in the standard contract or other documents); 0.25 points – the company has an official policy in the field of human rights protection and/or other regulatory documents, but the requirements for suppliers/contractors are not fixed in the contract and/or other documents; 0 points – there is no policy in the field of human rights protection or other regulatory documents establishing rules and standards in this area

Elements of social policy	Groups of indicators	Evaluation criteria
Interaction with local communities	Availability of a charity program	0.5 points – the company has a comprehensive charity program and a volunteer movement; information about charity expenses is publicly available; 0.25 points – the company implements individual/one-time charity projects; 0 points – the company does not conduct charitable activities
	Social investments and development of the regions of presence	0.5 points – the company implements a comprehensive program in the field of education/healthcare/social services, provision/infrastructure (construction of schools, hospitals, roads, assistance to the poor, etc.) in the regions of presence; 0.25 points – the company implements individual projects in the field of education, healthcare, social services, provision, infrastructure (construction of schools, hospitals, assistance to the poor, etc.) in the regions of presence; 0 points – the company implements no such projects

The proposed tools for accounting for non-financial risks can be demonstrated by a visual example (on the data for the construction materials industry enterprises as of 30.06.2021).

The determination of the discount rate of cash flow on proprietary invested capital for an enterprise is carried out with the current (traditional) and proposed justification of the specific enterprise's risks is provided in Table 5.

Table 5. Current (traditional) and proposed justification of the specific enterprise's risks

Indicator	Value	Value calculated using proposed tools	Source of information
Risk-free rate (Rf)	7.30%	7.30%	The rate of return on OFZ according to the website of the Central Bank of the Russian Federation
Coefficient β	1.14	1.14	The beta coefficient is adopted according to market data for the building materials industry without regard to leverage http://www.stern.nyu.edu/~adamodar/ The D/E indicator according to actual company data
Market Risk Premium (Rm – Rf)	6.15%	6.15%	Calculated as the difference between the arithmetic mean yield on corporate stocks and long-term treasury bonds of the US government; equals 6.15%
Premium for small companies; takes into account the size of the evaluated company (S1)	5.01%	5.01%	Premium size for the company size (based on the Evaluation Handbook – Guide to Cost of Capital, 2017)
Premium for the risk of investing in a specific company (S2)	2.86%	3.23%	Justification is provided after the table

Indicator	Value	Value calculated using proposed tools	Source of information
Discount Rate (CAPM)	22.18%	22.54%	Calculation
Cost of debt financing	10.50%	10.50%	The actual rate of attracting financing by the enterprise
Discount Rate (WACC)	19.43%	19.72%	Calculation

Substantiation of factors influencing the specific risk of the assessed company is provided in Table 6.

Table 6. Substantiation of factors influencing the specific risk of the assessed company

Risk factor	Traditional rationale	Proposed additional justification tools
Legislative risks	Adopted at the average level, since no initiatives that can affect the company's business have been identified in the cement production industry	
Set price level	Adopted at a high level, because the market competition is strong	
Dependence on key employees	Accepted at an intermediate level	A score of 1.25 was calculated for this enterprise, which characterizes the risk as increased
Quality of corporate governance	Accepted at a high level, since management of current assets requires sufficiently high competencies.	The company does not prepare non-financial statements. The risk is assessed as increased
Dependence on key consumers	Accepted at a high level, since the level of cement consumption in the region of the company's location and neighboring regions largely depends on several key projects in the construction industry that are being implemented as of the valuation date	
Dependence on key suppliers	Accepted at a low level, since the company has valid licenses for the development of key raw materials deposits. The company supplies itself with 98% of its quality raw material base (required for a raw material mixture consisting of 3 components) required for "dry" production (raw material mixture humidity <5%). The raw materials comply with GOST standards and are optimal for the production of cement of consistently high quality	
Logistical risks	Accepted at an average level due to satisfactory access to both raw material deposits and sales markets	
Risks related to business development prospects	Taken at the secondary level, since along with good company performance there are downside risks in the industry caused by the impact of COVID-19 on the global economy	The company does not implement environmental management systems. The risk is assessed as increased
Technological risks	Taken at the secondary level in connection with the specifics of the business	

Risk factor	Traditional rationale	Proposed additional justification tools
Financial risks	Taken at the average level on the basis of the evaluator analysis of the financial condition of the company	
Other risks	Taken at the average level, since neither low nor high risk for this type of business is revealed	

The premium amount is calculated depending on the values presented in the Table 7.

Table 7. The premium amount is calculated depending on the values

Degree of risk	Calculated value of the degree of risk	The amount of premium for a specific risk, %
Low	= 1, but <1.5	0–1
Average	>=1.75, but < 2.25	2–3
High	>= 2,75–3	4–5

Based on the analysis of factors, the algorithm provided in the Table 8 is used to determine the premium for the specific risk of the assessed company:

Table 8. Determination of the premium for a specific risk of the assessed company

Risk factor	Degree of risk			Result (traditional justification)	Result (extended justification)
	Low	Average	High		
Legislative risks	1	2	3	2	2
Set price level	1	2	3	3	2
Dependence on key employees	1	2	3	2	3
Quality of corporate governance	1	2	3	3	3
Dependence on key consumers	1	2	3	3	3
Dependence on key suppliers	1	2	3	1	1
Logistical risks	1	2	3	2	2
Risks related to business development prospects	1	2	3	2	3
Technological risks	1	2	3	2	2
Financial risks	1	2	3	2	2
Other risks	1	2	3	2	2
Total (amount)				24	26
Number of factors				11	11
Degree of risk				2.182	2.364

The calculated degree of risk is the result of dividing the sum of the degrees of risk by the number of risk factors; it equals:

2.182 for traditional justification, which corresponds to the degree of risk of 2.86%.

2.364 for extended justification, which corresponds to a risk level of 3.23%.

Literature Review

Recently, international and European associations of appraisers, as well as recognized methodologists, have been heeding close attention to the issues of incorporating ESG factors into an assessment.

Cornell, Bradford and Damodaran, Aswath [14] outline the main factors that should be considered in the development of an assessment methodology.

The International Valuation Standards Committee (IVSC) published three forward-looking papers on ESG in 2021. At the same time, the committee has not yet approved official standards in this area as of the date of preparation of this article.

The first IVSC «Perspectives Paper» on ESG and Business Valuation [15] dated March 2021 attempts to identify ESG characteristics that can be included in the value measurement process.

In the second «Perspectives Paper» ESG and Real Estate Valuation [16], published in May 2021, the relationship between investment in ESG and the creation and/or maintenance of the value of intangible assets and the resulting approaches to determining the degree of influence of ESG were the subject of research.

In October 2021, the third IVSC study [17] was published, representing the first steps of the IVSC towards a more systematic approach to incorporating ESG into business valuation practices and standards. While the previous two perspective papers have looked at ESG from a business and intangible asset perspective, the third perspective paper explores how ESG can be quantified as part of the real estate asset valuation process.

IVSC has also established an ESG working group, which includes representatives from the IVSC Standards Review Boards, stakeholders, and external experts to further discuss market needs [18].

As a result of the analysis of IVSC publications, it was revealed that the focus of attention in incorporating ESG factors in business valuation is on accounting for intangible assets, the procedure for selecting analogues in the comparative approach and when calculating the beta coefficient, analyzing forecast duration, the impact of tax incentives, revenue and cost forecasts. At the same time, no attention is paid to specific risk determination methods associated with ESG factors.

The ninth edition of the European Valuation Standards [19], published by TEGOVA and entered into force on 01.01.2021, includes a number of sections that are somehow related to ESG principles and incorporates them in determining the value.

The latest edition of the RICS Global Assessment Standards ("Red Book Global Standards"), which came into force on January 31, 2022, includes definitions and additional comments on issues related to ESG factors [20].

These studies mainly focus on the specifics of real estate valuation and do not cover the business valuation sphere, as well as ways to calculate ESG risks into the valuation.

It should be noted that a number of researchers pay attention to the impact of the ESG agenda on company capitalization [21], but do not offer a practical solution to the problems of incorporating specific risks in the discount rate for practical business assessments.

As a result of the analysis of the literature in regard to the definition of specific risks used by analysts and researchers, significant differences in the authors' opinions, a different set of factors and wide ranges of factor values were revealed.

G.R. Trugman [21] does not indicate the range of factor values, noting the need to incorporate the enterprise's financial and non-financial risks.

Z.Ch. Mercer [23] recommends a range of 0–5% for the degree of risk for each factor, while the aggregate indicator should not exceed 35%. In a later publication by the same author [24], the cumulative indicator is defined in the range from 0 to 8% and above.

Deloitte & Touche in different publications [25; 26] suggests using a smaller range from 0 to 3% for individual factors, while the cumulative adjustment cannot exceed 12%, and indicates a 3 to 8% range of cumulative adjustments for all factors.

The authors have not revealed more recent and detailed studies on this issue. At the same time, it should be noted that the publications do not specify the tools for determining the value of a risk factor in the proposed ranges. That is, the assigned factor indicator value is subjective, and there are no guidelines or ideas for their assignment.

Discussion

The influence of ESG factors characteristic of an enterprise in the assessment of its business from the profitability viewpoint entails:

- the projected level of income and expenses of the company, or cash flows,
- the discount rate at which the enterprise's projected cash flows are recalculated into the current value and reflect the risks of investing in a particular business.

The issue discussed in this article is the consideration of ESG factors when constructing a discount rate model for business valuation.

To determine the cost of the enterprise's own capital within the framework of the cash flow discounting method, the income approach is used, as a rule:

- long-term asset valuation model (capital asset pricing model – CAPM) when discounting cash flows on equity.
- weighted average cost of capital (WACC) model when discounting cash flows on invested capital

The influence of ESG factors of the assessed business on discount rate components is provided from the point of view of the author of the article in Table 9.

Table 9. The influence of ESG factors of the assessed business on discount rate components

Discount rate component	Influence of ESG internal factors	Comments
The rate of return on investments in risk-free assets (Rf)	no influence	Accepted at the level of risk-free assets (that is, assets with zero-risk investments). Profitability of government securities is usually considered.
Coefficient β	influence is present	Reflects the sensitivity of the security profitability indicators of a particular company to changes in market (systematic) risk. When analyzing the market indicators of the β coefficient, the influence of external ESG factors is due to the investors' attitude to changes in the enterprise industry.
Market Risk Premium (Rm – Rf)	no influence	The amount by which the average market rates of return on the stock market exceeded the rate of return on risk-free securities for a long time. Calculated on the basis of statistical data on market premiums for a long period and forecasts of their changes.
Premium for small companies; takes into account the size of the evaluated company (S1)	no influence	As follows from the economic meaning of the size premium, it reflects greater profitability of small companies compared to large companies, which, accordingly, is calculated into the risk rate.
Premium for the risk of investing in a specific company (S2)	influence is present	The risk factors of investing in a particular company are based on the analysis of company activities in the context of the specifics of its activities, projects, analysis of contractual relations, legislative risks, fixed price level, dependence on key employees, quality of corporate governance, risks associated with business development prospects, etc.
Cost of interest-bearing debt (Rd)	influence is present	Debt financing rate for a number of companies implementing ESG principles may be lower due to preferential loans, "green" bonds, etc.
Corporate Tax Rate (Tc)	influence is present	Effective corporate tax rate for a number of companies implementing ESG principles may be lower due to government support programs

The study of the discount rate component "Risk Premium for investments in a specific company (S2)", which has a significant impact on ESG factors specific to a particular business, is of particular interest.

If the cash flows generated by a company or a project are risk-free, i.e. they are expected with 100% probability, then there is no reason to account for the specific risk of investing in this company. Considering the fact that business is by definition characterized by entrepreneurial risk and its activities are influenced by numerous internal and external factors, it is quite difficult to imagine cases of risk-free receipt of forecast flows.

Since each business is unique in its own way, the risks associated with expected cash flows require analysis and accounting, and the greater the risks, the greater the investment risk premium. This premium is additional income that must be added to the risk-free rate in order to compensate the investor for the resulting risk. Since there are different approaches to determining the risk premium, and the premium is calculated in different periods, opinions on the value of this indicator differ significantly.

The complexity of accounting for this indicator is due to the lack of an objective data source to properly reflect or quantify a specific premium for a specific company risk. This is a matter of judgment and experience of the specialist performing the calculation. Many of the risk factors that are taken into account when determining the appropriate discount rate are the same factors that the valuation analyst uses to adjust the coefficients received from the reference companies in accordance with the market approach.

The proposed approaches to determining specific risks can be divided into two directions – qualitative and quantitative.

Despite the trend in the development of approaches, which provides for a transition from more subjective (qualitative) to more objective (quantitative) methods, in the context of the development of Russian business, qualitative research methods remain the most frequently used.

This factor is due to the following factors:

- The Russian stock market lacks the participation of individuals. The population has just begun to enter the financial market.
- The resources of institutional investors are insignificant; i.e., funds do not compete for profitability in the market of non-state pension funds (NPFs) due to regulation costs and the freezing of the pension savings system since 2014.
- Competition is declining, and the investment climate is unsatisfactory, which reduces the interest of Russian companies in raising capital (including through IPOs). Finally, the debt market and the derivatives market volumes are insufficient.

- Qualitative methods are characterized by the determination of the premium values for various types of specific risks based on the subjective professional opinion of an analyst who operates according to the following algorithm:
- selects the most significant factors of specific risks of the company being evaluated based on his experience and vision.
- assigns appropriate values to each type of specific risk (in percentage points – from the selected acceptable range of values).
- determines the total premium amount for specific company risks as the sum of all assessed premiums for each specific selected risk factor.

The literature provides various specific risk factors of the enterprise, which, as a rule, include, but are not limited to the following, presented in the Table 10.

Table 10. Specific risk factors in the literature

Source	Risk Factors	Range, %
1	**Financial:** • economic risk • business risk • operational risk • financial risk • asset risk • product risk • market risk • technological risk • regulatory risk • legal risk **Non-financial:** • economic conditions • industry conditions • location of the business • competition • control depth • quality of management • barriers to market entry	Not specified
2	• key indicators and company management • company size • financial structure • product/geographical diversification • customer diversification • profit: margin and historical predictability • other specific factors	0–5 Cumulative indicator 0–35%

Source	Risk Factors	Range, %
3	• dependence on key employees; • quality of corporate governance; • dependence on key consumers of services; • dependence on key suppliers.	0–3 Cumulative indicator 0–12
4	• dependence on key employees • quality of corporate governance • dependence on key consumers of electricity and heat that can influence the company's activities • dependence on key suppliers of raw materials, materials and services • that can influence the company's activities • restriction of access to borrowed capital • falling demand for electricity as a result of the introduction of energy-saving technologies • risk of slowing down the electric power industry reform and liberalization of the gas market	Cumulative indicator 3–8
5	• risks associated with key personnel (or lack of managerial capabilities, management depth), • risks of the absolute company size, financial structure • concentration risks (regarding the types of products, geographical location of activities or clientele), • stability risks and profit predictability, • other risks associated with a particular company.	Cumulative indicator 0–8 or more

Note that among the precise risk factors specific to a particular company, its non-financial indicators are explicitly or implicitly taken into account, which reflects their impact on the value of a business.

This fact is confirmed by one of the most popular concepts of value today, according to which various models of business valuation are being developed with regard to the impact of sustainable development, is the concept of "stakeholder" business value. According to this approach, "a business has value not only as a cash-generating unit, but also as an object with a positive and negative impact on interested parties ("stakeholders")".

A few years ago KPMG shared the opinion [27] that the creation or reduction of public value by a company has an increasingly direct impact on the drivers of corporate value, namely income, costs and risk.

The "true value" method of determining fair value proposed by the company [28] provides for the determination of positive and negative externalities and their monetization, that is, quantitative assessment. Then the information obtained should be combined with financial indicators, and specifically with the company's profit, in order to provide a comprehensive view of the cost.

The company has also developed a classification of a company's external effects, which are divided into economic, social and environmental, both positive and negative. It is noted that classification boundaries can be expanded – you can add external effects related to a specific company.

Taking the above circumstances into account, the author proposes a model for reflecting ESG risks when forming a discount rate during business valuation.

Conclusions

Clarification of the specific risk factor allowed:

- provide an expanded and reasoned judgment about the specific risks associated with the company's activities in order to form an objective opinion about the company's activities and risks;
- affected the calculation of the discount rate (an increase from 19.43 to 19.72%), which, when analyzing the cost of the company's equity, led to an adjustment (clarification) of the evaluation result.

In conclusion, it can be noted that the models and justifications used in traditional approaches to business valuation should be developed with regard to emerging modern requirements, in particular, taking ESG factors into account. Historically, external factors have had no impact on the income, expenses and cash flows generated by companies.

In modern conditions, globalization, digitalization, global financial crises, population growth, poverty, climate change and other socio-environmental factors are transforming business landscapes. As a result, the above external factors are internalized, opening up new opportunities,

or vice versa – new risks with significant consequences for companies. In this regard, in the generally accepted and applied methods of assessing business with a profitable approach, additional factors that affect reliable business assessment have been proposed.

The presented tools, which complement the traditional assessment methods due to the use of additional factors on a point scale and their subsequent translation into correction coefficients by the expert assessment method, already allow them to be applied in practice today.

References

1. Environmental, social, and governance (ESG) investing in the United States. Cerulli Associates. 2019. URL: https://info.cerulli.com/US-ESG-2019.html
2. Pastor L., Stambaugh R.F., Taylor L.A. Sustainable investing in equilibrium NBER Working Paper. 2020;(26549). URL: https://www.nber.org/system/files/working_papers/w26549/w26549.pdf
3. Akhmetshina A., Kaspina R., Vagizova V., Ivanov S. Business model as a tool for increasing the market capitalization and reducing environmental impact of the company. *Procedia Environmental Science, Engineering and Management*. 2020,7(3):367-373. URL: http://www.procedia-esem.eu/pdf/issues/2020/no3/10_42_Akhmetshina_20.pdf
4. Khorin A., Krikunov A. ESG-risk factors and value multiplier of telecommunications companies. *Journal of Corporate Finance Research*. 2021;15(4):56-65. https://doi.org/10.17323/j.jcfr.2073-0438.15.4.2021.56-65
5. Ashwin Kumar N.C., Smith C., Badis L., Wang N., Ambrosy P., Tavares R. ESG factors and risk-adjusted performance: A new quantitative model. *Journal of Sustainable Finance & Investment*. 2016;6(4):292-300. https://doi.org/10.1080/20430795.2016.1234909
6. Cornell B. ESG preferences, risk and return. *European Financial Management*. 2021;27(1):12-19. https://doi.org/10.1111/eufm.12295
7. Efimova O.V. Integrating sustainability issues into investment decision evaluation. *Journal of Reviews on Global Economics*. 2018;7:668-681. https://doi.org/10.6000/1929-7092.2018.07.61
8. Feoktistova E.N., Alenicheva L.V., Dolgikh E.I., Kopylova G.A., Ozeryanskaya M.N., Khonyakova N.V. Analytical review of corporate non-financial reports: 2015-2016. Moscow: Russian Union of Industrialists and Entrepreneurs; 2017. 136 p. URL: https://rspp.ru/document/1/7/4/743222fc4c6650093518c635d0e8ecdd.pdf (In Russ.).
9. Zakhmatov D.Yu. The attitude of corporate business in the Russian Federation to the management of environmental, social risks, as well as corporate governance risks (ESG risks). *Kazanskii ekonomicheskii vestnik = Kazan Economic Bulletin*. 2021;(6):29-38. (In Russ.).
10. Feoktistova E.N., Alenicheva L.V., Kopylova G.A., Ozeryanskaya M.N., Purtova D.R., Khonyakova N.V. Analytical review of corporate non-financial reports: 2017-2018. Moscow: Russian Union of Industrialists and Entrepreneurs; 2019. 104 p. URL: https://рспп.рф/download/a48b14d9858856285b5f7aba0c57b076/ (In Russ.).
11. Berg F., Kölbel J.F., Rigobon R. Aggregate confusion: The divergence of ESG ratings. *SSRN Electronic Journal*. 2019. http://dx.doi.org/10.2139/ssrn.3438533
12. A practical guide to sustainability reporting using GRI and SASB standards. Amsterdam: Global Reporting Initiative; 2021. 42 p. URL https://www.globalreporting.org/media/mlkjpn1i/gri-sasb-joint-publication-april-2021.pdf
13. Verles M., Vellacott T. Business and the sustainable development goals: Best practices to seize opportunity and maximise credibility. Geneva: Gold Standard; 2018. 19 p. URL: https://www.goldstandard.org/sites/default/files/documents/sdg_report_optimized.pdf
14. Cornell B., Damodaran A. Valuing ESG: Doing good or sounding good? *SSRN Electronic Journal*. 2020. http://dx.doi.org/10.2139/ssrn.3557432
15. Perspectives paper: ESG and business valuation. IVSC. Mar. 02, 2021. URL: https://www.ivsc.org/perspectives-paper-esg-and-business-valuation/
16. Perspectives paper: A framework to assess ESG value creation. IVSC. May 26, 2021 URL: https://www.ivsc.org/a-framework-to-assess-esg-value-creation/
17. Perspectives paper: ESG and real estate valuation. IVSC. Oct. 14, 2021 URL: https://www.ivsc.org/esg-and-real-estate-valuation/
18. Aronsohn A. Survey: ESG & valuation. IVSC. Feb. 14, 2022. URL: https://www.ivsc.org/esg-survey/
19. European valuation standards (EVS). TEGOVA. 2021. URL: https://tegova.org/european-valuation-standards-evs
20. RICS valuation – global standards. London: RICS; 2021. 296 p. URL: https://www.rics.org/globalassets/rics-website/media/upholding-professional-standards/sector-standards/valuation/2021-11-25_rics-valuation--global-standards-effective-2022.pdf
21. Ilhan E., Sautner Z., Vilkov G. Carbon tail risk. *The Review of Financial Studies*. 2021;34(3):1540-1571. https://doi.org/10.1093/rfs/hhaa071
22. Trugman G.R. Understanding business valuation: A practical guide to valuing small to medium sized

businesses. 3rd ed. New York: American Institute of Certified Public Accountants; 2008. 943 p.

23. Mercer Z.C. The adjusted capital asset pricing model for developing capitalization rates: An extension of previous "build-up" methodologies based upon the capital asset pricing model. *Business Valuation Review*. 1989;8(4):147-156. https://doi.org/10.5791/0882-2875-8.4.147
24. Mercer Z.C., Harms T.W. Business valuation: An integrated theory. Hoboken, NJ: John Wiley & Sons, Inc.; 2008. 288 p.
25. Practical guide to valuating RUSNANO assets. Moscow: ROSNANO; 2010. 132 p. URL: https://www.ocenchik.ru/site/met/rosnano1.pdf (In Russ.).
26. Methodology and guidelines for conducting business and/or assets valuation of RAO "UES of Russia" and SDCs of RAO "UES of Russia". Deloitte & Touche. 2007. URL: https://www.ocenchik.ru/method/business/260/ (In Russ.).
27. Dellham D., Mueller H. A new vision of value: Connecting corporate and societal value creation. Amstelveen: KPMG; 2014. 116 p. URL: https://home.kpmg/content/dam/kpmg/pdf/2014/11/A-New-Vision-of-Value.pdf
28. The true price of jeans. Amsterdam: Impact Institute; 2019. 30 p. URL: https://trueprice.org/wp-content/uploads/2019/06/Impact-Institute-Report-True-Price-of-Jeans.pdf

Contribution of the authors: the authors contributed equally to this article.

The authors declare no conflicts of interests.

The article was submitted 16.01.2022; **approved after reviewing** 18.02.2022; **accepted for publication** 14.03.2022.

DOI: https://doi.org/10.17323/j.jcfr.2073-0438.16.1.2022.99-112
JEL classification: C23, G17, G23, G32

Comparative Analysis of the Predictive Power of Machine Learning Models for Forecasting the Credit Ratings of Machine-Building Companies

Sergei Grishunin ✉
Candidate of Sciences (PhD), CFA, Senior Lecturer, Graduate School of Industrial Economics, Institute of Industrial Management, Economics and Trade,
Peter the Great St. Petersburg Polytechnic University, Saint Petersburg,
Russia, sergei.v.grishunin@gmail.com, ORCID

Alexandra Egorova
Manager, Deloitte and Touche, Moscow, Russia,
alxegorova@gmail.com, ORCID

Abstract

The purpose of this study is to compare the predictive power of different machine learning models to reproduce Moody's credit ratings assigned to machine-building companies. The study closes several gaps found in the literature related to the choice of explanatory variables and the formation of a data sample for modeling. The task to be solved is highly relevant. There is a growing need for high-precision and low-cost models for reproducing the credit ratings of machine-building companies (internal credit ratings). This is due to the ongoing growth of credit risks of companies in the industry, as well as the limited number of assigned public ratings to these companies from international rating agencies due to the high cost of the rating process. The study compares the predictive power of three machine learning models: ordered logistic regression, random forest, and gradient boosting. The sample of companies includes 109 machine-building enterprises from 18 countries between 2005 and 2016. The financial indicators of companies that correspond to Moody's industry methodology and the macroeconomic indicators of the companies' home countries are used as explanatory variables. The results show that artificial intelligence models have the greatest predictive ability among the models studied. The random forest model demonstrated a prediction accuracy of 50%, the gradient boosting model - 47%. Their predictive power is almost twice as high as the accuracy of ordered logistic regression (25%). In addition, the article tested two different ways of forming a sample: the random method and one that accounts for the time factor. The result showed that the use of random sampling increases the predictive power of the models. The incorporation of macroeconomic variables into the models does not improve their predictive power. The explanation is that rating agencies follow a "through the cycle" rating approach to ensure rating stability. The results of the study may be useful for researchers who are engaged in assessing the accuracy of empirical methods for modeling credit ratings, as well as banking industry practitioners who use such models directly to assess the creditworthiness of machine-building companies.

Keywords: credit ratings, internal credit ratings, machine-building companies, machine learning models, rating agencies

For citation: Grishunin, S., and Egorova A. Comparative Analysis of the Predictive Power of Machine Learning Models for Forecasting the Credit Ratings of Machine-Building Companies. *Journal of Corporate Finance Research.* 2022;16(1): 99-112. https: //doi.org/10.17323/j.jcfr.2073-0438.16.1.2022.99-112

Introduction

In the past few years the fourth industrial revolution has fundamentally changed the business environment and business models of machine-building companies (MBC). It provides new opportunities for profit and increases company value in this industry, but exposes them to elevated risks. The dangers are as follows: 1) uncertainty in regard to key suppliers and delivery prices; 2) reduction of the product life cycle; 3) discontinuity of operations caused by technology breakdowns, information failures and outer interference; 4) shortage of qualified staff at all levels; 5) increased competition created by manufacturers from emerging markets, as well as by companies from other industries; 6) other internal and external risks [1]. Growing uncertainty, volatility and variability of the external and internal environment increase the probability of default of MBC. This makes relevant the task of constructing high-precision models of MBC credit risk assessment. Investors need these models to evaluate MBC creditworthiness within the planning horizon and the landscape of making decisions on provision of financing.

In order to assess MBC creditworthiness, investors use credit ratings (CR) assigned by expert international rating agencies, such as Moody's Investor Service, Fitch Ratings or Standard and Poor's [2]. They provide an opportunity to thoroughly examine MBC's financial and business profiles, evaluate their advantages and disadvantages and predict the likelihood of MBC's timely settlement of their financial obligations. CR also helps to compare the credit quality of companies from various countries and markets [3]. The credit rating is a kind of MBC's "seal of excellence". It enables MBC to appeal to more investors as well as to increase the amounts and periods of financing, reduce the cost of capital and gradually increase the probability of cooperating with investors when their credit profile is improved [4].

The high cost of assigning and maintaining a CR, as well as the demanding requirements of international rating agencies for the minimal company size and quality of corporate governance are among the drawbacks of a CR [3]. Therefore, the scope of a CR use is limited to large multi-industry manufacturers, mainly from developed markets. Thus, credit ratings do not cover small and medium-size MBC or firms from emerging markets because they lack the financial and organizational resources to maintain a CR. Another disadvantage of a CR is big update intervals, typically, one year long [4].

In order to eliminate these blind spots, investors evaluate internal credit ratings (ICR) of companies, including MBC. The approach, which has proved to be efficient, implies a reproduction of the missing credit ratings using empirical models based on public financial and non-financial company data [3]. The obtained ICR are unbiassed and uncostly assessments of companies' creditworthiness. However, the predictive power of ICR (i.e. the ability to reproduce CR accurately) varies greatly depending on the models at the basis of the ICR [5]. In its turn, the literature review demonstrated that the majority of studies in this sphere use companies from numerous industries (as a rule, from developed countries) as a sample, thus leaving out the specific nature of MBC's operations and special features of their work in developed markets. Some other drawbacks were also revealed: a small observation period in samples and inconsistency of explanatory variables in the models with the factors used by international rating agencies.

Our research fills the abovementioned gaps in literature. Its purpose is to 1) compare the predictive power of different machine learning models in order to reproduce Moody's credit ratings focused on MBC; and 2) to define the optimum model in terms of data availability, forecast accuracy and result interpretability. For modelling we selected the creditworthiness factors which explicitly examine the special aspects of MBC operations and correspond to Moody's credit rating methodologies. The MBC sample comprises companies from both developed and emerging markets. We have also verified whether the addition of macroeconomic factors enhances the accuracy of CR prediction, as demonstrated in literature [6]. We use the 2005–2016 period in this paper. Research results may be useful to theorists who evaluate the accuracy of empirical CR modelling methods and practicians who use such models to assess MBC's creditworthiness.

Setting the Objective and Description of the Research Model

Literature review

There is a range of models aimed to assess and predict credit ratings. They differ in their assumptions. The majority of studies use linear regression, logistic regressions or the discriminant analysis method. These are standard approaches to credit rating modelling. Besides, some studies use neural networks or duration and hazard models to predict rating transitions.

Econometric Methods

Early studies [7] use the univariate parameter method to predict the probability of default. Later Altman [8] used linear discriminant analysis in his paper to predict credit quality. At the close of the XX century logit and probit models were first applied because they have a greater predictive power than the models that use the discriminant and quadratic discriminant analysis. Martin [9] and Ohlson [10] were the first ones to use logit regression to construct a model of bank bankruptcy probability. Empiric studies [11] revealed that ordered logistic regression models yield more results and have a greater predictive power than the least squares and discriminant analysis methods. The ordered logistic regression method is used in many new studies dedicated to business and economics issues [12–14]. This method is superior in defining credit ratings because of its ordered structure. Apart from that, it was noted that those methods had the greatest predictive power in comparison to linear regression, linear discriminant analysis, quadratic discriminant analysis and discriminant analysis of the mixture of distributions.

At present a lot of studies are dedicated to the use of the LASSO model [16] in order to search for the parameters that are most significant for the prediction of corporate credit rating.

Machine Learning Methods

The issue of assigning a credit rating may be considered a classification objective as well. In the XXI century machine learning methods which were used to forecast the probability of default and corporate credit quality have gained popularity. Machine learning models may be "trained" using the sample of ratings and corresponding data. For example, in neural networks training is defined as a search for weights in order to obtain the most accurate result [17]. However, the majority of such studies are conducted beyond the scope of economic analysis, as part of development and use of alternative methods in informatics.

Support Vector Machines (SVM) [18] were proposed as a method characterized by a great predictive power, however, its formation requires numerous financial and non-financial indicators. Apart from Support Vector Machines, classification trees [19–21] and neural networks [22–24] gained popularity in terms of rating prediction and probability of bankruptcy. Thus, in some studies Support Vector Machines and neural networks method demonstrate the same predictive accuracy of about 80% [25]. Comparison of the predictive power of the neural network model to linear discriminant analysis when forecasting Moody's ratings for different companies [26] showed that the use of a neural network delivers accuracy of 79%, which exceeds the result of discriminant analysis (33%).

Gradient boosting is another alternative method of credit rating forecasting. Paper [27] proves that gradient boosting outperforms the decision tree method from the viewpoint of the credit scoring models' predictive power. Another paper [28] notes that the gradient boosting algorithm demonstrates the greatest predictive power in the random forest, decision trees and neural networks models.

Each of the above methods of credit rating forecasting has its advantages and disadvantages. For instance, econometric methods are easy to use and interpret. However, these methods have low predictive power and amounts to 40–50% on average [11]. Apart from that, it is necessary to select data before using it in econometric methods. Machine learning models have a great predictive power, however, the majority of them are uninterpretable and may be subject to data overfitting [29].

Explanatory Variables

Literature defines three groups of factors that explain CR. The first category comprises financial ratios and financial data [11]. The second category consists of corporate management and risk management factors [14; 30]. The third category includes macroeconomic factors. Studies [5; 13] reveal that in case of CR prediction for financial organizations, the introduction of macroeconomic variables in the models significantly improves the quality of model fitting and enhances its predictive power. However, when CRs were modelled for non-financial companies, some of the macroeconomic indicators (i.e., GDP growth) turned out to be insignificant or their signs failed to meet expectations [6]. A major issue in the selection of variables for analysis is multicollinearity between dependent variables [13], therefore, the choice of the model specification and variable selection assume a great significance.

Absence of focus on a certain industry (in our case it's machine building) is a gap in CR modelling because in the majority of studies CR modelling is performed using a sample of companies from various industries (in most cases the industries are identified by introducing dummy variables into the models). This makes it impossible to clearly define the explanatory variables characteristic of a certain industry. Also, companies from certain countries (Taiwan, USA, Korea, China) are examined, preventing one from generalizing the results of modelling of a wide range of such companies. Besides, studies are limited by the following: 1) a short time interval applied in the samples; 2) use of explanatory variables other than the ones utilized by rating agencies. The purpose of this paper is to fill the above gaps in studies.

Research Methodology

We have built an MBC credit quality assessment model that emulates Moody's rating. For this purpose, we applied the following methods: ordered logistic regression (OLR), random forest (RF) and gradient boosting (GB).

For an MBC, the model predicting CR may be expressed as follows:

$$Y_t = f(X_{1t} \ldots X_{nt}), \quad (1)$$

where Y_t is a dependent variable, MBC's credit rating assigned by Moody's at the time t. The agency assigned a rating expressed as a literal notation in accordance with its own scale [34]. We transferred the rating to a qualitative scale, where whole numbers correspond to literal notations of the rating, they are presented in ascending order: the lower the rating, the bigger the number (Table 1);

$X_{1t}, \ldots, X_{nt}$ is a set of n explanatory variables defined at the time t.

$Y_t = \tau_t$ is a numerical value of rating from Table 1.

Table 1. Numerical scale of dependent variable (transfer of the Moody's rating literal notation into an order scale)

Moody's rating	AAA	Aa1	Aa2	Aa3	A1	A2	A3	Baa1	Baa2
Numerical rating value (τ)	1	2	3	4	5	6	7	8	9
Moody's rating	Baa3	Ba1	Ba2	Ba3	B1	B2	B3	Caa1–Caa3	C–Ca
Numerical rating value (τ)	10	11	12	13	14	15	16	17	18

Source: [34].

Ordered logistic regression. As long as the dependent variable Y_t is an ordered one and accepts k values of the rating levels $k\epsilon$)[1; 18], we applied ordered logistic regression (OLR) [6]. We introduce the latent variable z related to the rating value and dependent variables as follows:

$$\begin{cases} z_i = 1, \ if \ z_i = x_i'\theta + e_i \le \tau_1; \\ z_i = r, \ if \ \tau_{r-1} \le z_i = x_i'\theta + e_i \le \tau_r, 2 \le r \le k-1, \\ z_i = k, \ if \ z_i = x_i'\theta + e_i \ge \tau_{k-1}, \end{cases} \quad (2)$$

where i is the observation sequential number; τ_r are threshold values of the rating level cut-off; e_i – errors which are supposed to be estimated, normally distributed and have a zero mathematical expectation.

By using this model we expect to obtain an assessment of the coefficient vector Θ, as well as a set of threshold values of cut-offs for each rating level (τ_1,τ_{k-1}) by applying the maximum likelihood method for the system of the following equations:

$$\begin{cases} P(y_1 = 0) = F(\tau_1 - x_i'\theta); \\ P(y_i = r) = F(\tau_{r-1} - x_i'\theta) - F(\tau_r - x_i'\theta), 2 \le r \le k-1; \\ P(y_i = k) = F(\tau_{k-1} - x_i'\theta), \end{cases} \quad (3)$$

where $F(x)$ is a logistic function [6]; $P(y_i = r)$ is the probability of assigning MBC with the set of values x_i to the rating grade r.

In equation (3) standard errors are specified in the White-Huber form, thus reducing their heteroscedasticity. After obtaining Θ and τ scores, predictive probabilities $\widehat{P_j}$ from equation (3) are calculated. MBC is assigned the rating j, for which the value of $\widehat{P_j}$ is the biggest. We will use McFadden R^2 criterion [6] as a measure of quality of the model approximation to actual data, which is a variation of criterion R^2 widely used in econometrics. Other indicators presented in section 2 will also be quality criteria.

Random forest. Unlike OLR, random forest (RF) is a machine learning algorithm. which results in building of a multitude of decision trees models during training [32]. Output data is obtained on the basis of voting results of individual tree classes for the classification model and as an average response (averaging) – for the regression model [35]. The result of the rating forecasting objective is an average value of multiple regression trees

$$Y = f(x_1 \ldots . x_n) = \frac{1}{G}\sum_{g=1}^{G} h(x_i; T_g), \quad (4)$$

where G is the number of trees; h is the regression tree function obtained at the input T_g.

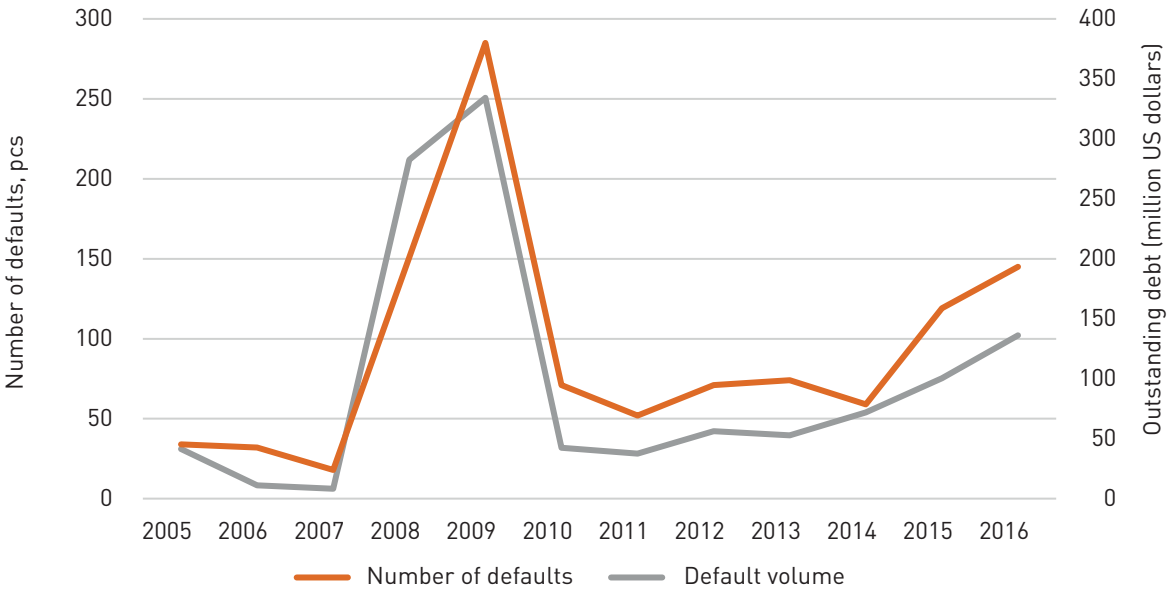
Gradient boosting (*GB*). This method is also an ensemble learning method, but it applies another ensemble formation strategy. The algorithm trains weak models consistently, in many iterations, taking into consideration the error of the whole ensemble defined at the moment in order to provide a more accurate assessment of the corporate credit rating. A gradient descent is used for optimization [36]

$$y = f(x_1 \ldots x_n, \hat{\theta}); \hat{\theta} = \\ = \underbrace{argmin}_{\theta} E_x \left[E_y \left(\varphi \left[y, f(x, \theta) \right] \right) | X \right], \quad (5)$$

where Θ – parameters for evaluation; $\varphi(y,f(x))$ – the target function.

Data and Explanatory Variables

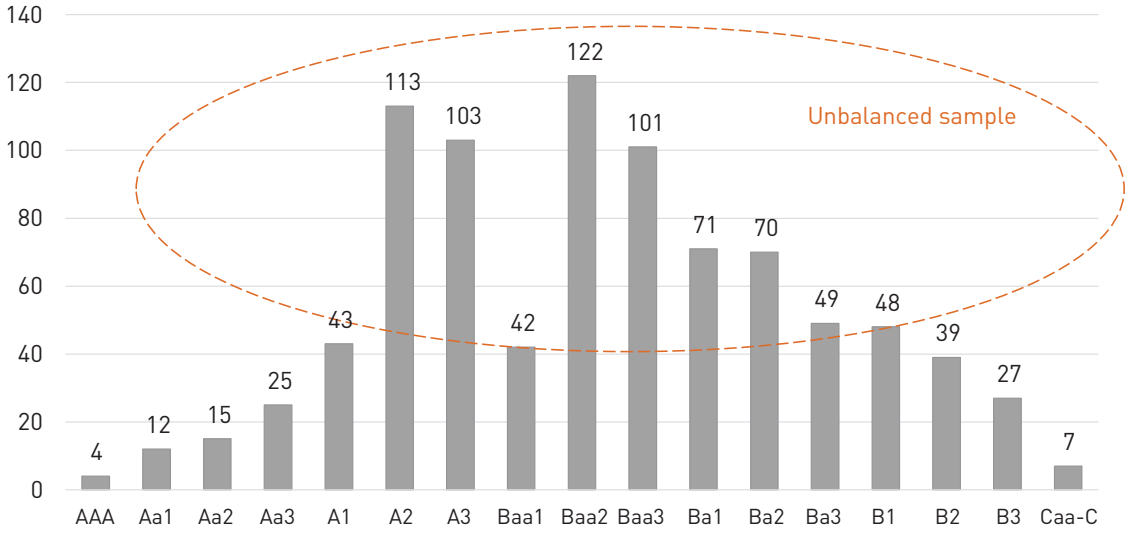
Figure 1. Credit cycle in financial markets in 2005–2016



Source: [34].

However, the sample is not balanced according to rating categories (Figure 2).

Figure 2. Distribution of MBC credit ratings in the sample



Source: [34].

In this paper we use financial and non-financial data of 109 companies engaged in different machine-building sectors of 18 countries. We present observations for each company for the period of 2005 to 2016. There are 891 observations in total. The data comprises observations of MBCs that manufacture machines and equipment for metalworking and mineral industry, power generating, medical industry, agriculture and construction industry. Motor manufacturers and manufacturers of machines and equipment for aerospace and defense industry are left out of the sample because Moody's uses another set of factors for these companies to explain their creditworthiness, which is described in separate methodologies.

The sample consists of 62 companies from the USA, 13 – from Japan, 8 – from Germany, 3 – from Sweden, 3 – from Great Britain, 3 – from France, 2 – from Finland, 2 – from Ireland and China each. Canada, Greece, Netherlands, Peru, Russia, Turkey, Mexico and Indonesia are represented by 1 MBC each. The temporal pattern of the dataset covered the entire credit cycle (Figure 1).

It is related to MBCs' high business risks caused by the industry's significant capital intensity, cyclical nature of demand, dependence on large customers, duration of the manufacturing cycle. These risks have a significant positive correlation with MBCs' credit risks. This limits the MBCs' capability to get high ratings (the average machine-building companies' rating assigned by Moody's is Baa3) [34].

Explanatory variables comprise financial indicators that represent MBCs' performance results, as well as macroeconomic variables in their countries of business. We used Moody's methodology for manufacturing companies [34] to make a list of financial indicators. Financial indicators and ratings data were obtained from Thomson Reuters Eikon, macroeconomic variable data – from the World Bank network. Table 2 contains the list of variables, their descriptive statistics and expected signs of influence on the rating.

Table 2. List of explanatory variables

Explanatory variable	Description	UOM	Formula	Expected sign	Mean value	Standard deviation
Indicators that define the nature of a company's business						
Share of gross investments in GDP	Amount of gross investments in fixed capital	%	Gross investments /GDP in the country of operation	"–"	20.8	20.4
Share in global manufacturing	Share in the global industry	%	Company's proceeds/ share of the added cost in the industry	"– "	0.14	0.21
Time trend	Time indicator	year	Number of years since the first observation	"+"	5	3

Explanatory variable	Description	UOM	Formula	Expected sign	Mean value	Standard deviation
Economic downturn flag	Indicator of economic depression	1/0	Dummy variable equals 1 if there is an economic downturn in the year of observation, 0 – otherwise	"+"	—	—
Private company flag	Indicator of a private company	1/0	Dummy variable equals 1 if the company is private, 0 – if it is government-owned	"+"	—	—
Resident in developed country flag	Indicator of operations in developed economies	1/0	Dummy variable equals 1 if the company operates in developed markets, 0 – otherwise	"– "	—	—
Quality of fixed assets	Quality of assets	%	Amortization/Assets	"+"	8.1	3.5
Market value to sales multiple	Ratio of the market value to proceeds	multiplier	$\frac{EV}{Sales} = \frac{MC + D - CC}{Annual\ Revenue}$, where *MC* – market capitalization; *D* – liabilities; *CC* – cash and cash equivalents	"–"	1.76	1.54
Market value to *EBITDA* multiple	Ratio of the market value to *EBITDA*	multiplier	$\frac{EV}{EBITDA} = \frac{MC + D - CC}{EBIT + DA + FI}$, where *EBITDA* – earnings before interest, taxes, depreciation and amortization; *EBIT* – earnings before interest and taxes; *DA* – depreciation and amortization; *FI* – other financial income	"–"	7.3	5.8
Interest paid	Interest which has been paid	multiplier	Company's annual interest costs	"+"	4.25	1.16
Profit Indicators						
Return on average equity (*ROAE*)	Return on average equity	%	$ROAE = \frac{NPATBUI}{Average\ Equity} \cdot 100\%$, where *NPATBUI* – Net Profit After Taxes Before Unusual Items	"–"	13.7	30.4
EBITDA margin	Cost-effectiveness of *EBITDA*	%	$EBITDA\ margin = \frac{EBITDA}{Revenue} \cdot 100\%$	"–"	15.0	6.0
Indicators of Debt						
Net debt/ EBITDA	Debt load ratio	multiplier	$\frac{Net\ debt}{EBITDA} = \frac{Debt - CC}{EBITDA}$	"–"	2.9	4.5

Explanatory variable	Description	UOM	Formula	Expected sign	Mean value	Standard deviation
Debt/Book Capitalization (*BC*)	Ratio between liabilities and book value of capitalization	%	$\frac{Debt}{BC} = \frac{Debt}{Book\,Value\,of\,Equity} \cdot 100\%$	"+"	61.8	12.7
Debt/Market Capitalization (*MC*)	Ratio between liabilities and company's market capitalization	%	$\frac{Debt}{MC} \cdot 100\%$	"+"	27.32	15.3
Cash ratio	Cash ratio	%	$Cash\,ratio = \frac{CC}{Debt} \cdot 100\%$	"–"	47.4	79.5
Retained cash flow (*RCF*) to net debt	Ratio of retained cash flow to net liabilities	%	$\frac{RCF}{Net\,debt} = \frac{CFO - \Delta WC - Div}{Debt - CC} \cdot 100\%$, where *CFO* – cash flow from operations; ΔWC – changes in working capital; *Div* – paid dividends;	"– "	75.2	23.2
Available RCF debt coverage	Retained cash flow available for settlement of debt	%	$\frac{Available\,RCF}{Debt} = \frac{RCF - Capex}{Debt} \cdot 100\%$, where *Capex* – capital expenditure	"–"	16.4	22.0
EBITDA interest coverage	Ratio of *EBITDA* coverage	multiplier	$\frac{(EBITDA - Capex)}{Interest}$, where *Interest* is paid interest	"–"	8.6	11.5
Liquidity Indicators						
Current ratio (*CR*)	Current liquidity ratio	multiplier	$CR = \frac{Current\,Assets}{Current\,Liabilities}$	"–"	1.9	0.7
Quick ratio (*QR*)	Acid test ratio	multiplier	$QR = \frac{CC + AR}{Current\,liabilities}$, where *AR* – accounts receivable	"–"	1.1	0.5
Macroeconomic Variables						
Real GDP growth	GDP growth rate	%	Annual growth rate of real GDP in the country of operations	"–""	1.6	2.1
Inflation	Inflation	%	Annual consumer price index	"?"	1.7	1.4

Explanatory variable	Description	UOM	Formula	Expected sign	Mean value	Standard deviation
Rule of law	Supremacy of law	multiplier	World Bank Index (WB)*, which measures efficiency of the legislative system, crime rate and citizens' attitude to crime in the country of business	"–"	—	—
Government effectiveness	Governmental authorities' efficiency	multiplier	WB index, which measures the quality of internal state policy, confidence in the government, the quality of the government mechanism operation in the country of business	"-"	—	—
Control of corruption	Corruption	multiplier	WB index, which measures perception of corruption in the society, existence of corruption at a high political level, influence of corruption on economic development in the country of business	"–"	—	—

Note. Numerical values of dependent variable scores are adjusted in such a way that a bigger value corresponds to the lowest score. Consequently, a positive sign denotes a negative influence of the explanatory variable on the dependent variable and vice versa.

* The methodology of World Bank's corporate governance indicators is described. URL: http://info.worldbank.org/governance/wgi/

Source: developed by the authors.

Data Preparation

We built a correlation matrix and excluded the most correlated variables (with paired correlation coefficients exceeding 0.8) in order to solve the multicollinearity problem in the OLR model. For other variables we evaluated the variance inflation factors (VIF) [37] and eliminated all variables with the VIF exceeding 5 from the sample. In order to evaluate the predictive power of explanatory variables, we also applied principal component analysis (PCA) [38]. When modelling ratings using machine learning methods, we applied the entire set of independent variables with no regard for the abovementioned selection. Machine learning methods are not susceptible to multicollinearity problem, while a large set of variables in ML allows to find the optimum combination of factors. In order to build models, in this paper we used the data not included in the set intended for verification of model quality (out of sample) at the ratio of 70% (training set) and 30% (test set).

Research Hypotheses

Hypothesis H1. Use of the gradient boosting model will provide an opportunity to get the greatest predictive power of the rating model. In other words, this model will demonstrate the greatest probability of concordance of the predicted and observed rating ($P\left(|\Delta| = 0\right)$. Consequently, the random forest model will be the second in predictive accuracy after gradient boosting. OLR will have the lowest predictive power among the three considered models. This corresponds with the evidence presented in paper [27]. Another reason against the high predictive power of the OLR model is that coefficients are assessed using the maximum likelihood function, and as long as the sample is unbalanced its results may be biased towards the most frequent rating values.

Hypothesis H2. Random data separation into the training and test samples will provide a greater predictive power for the model than data separation, which takes into consideration the time factor where the training set (70% of the sample) comprises data on the earliest observations and the test sample (30% of the sample) consists of the data on new observations. As long as the sample is unbalanced, we presume that a random separation into the training and test samples may provide a more accurate rating prediction.

Hypothesis H3. Addition of macroeconomic variables to the model will improve its predictive power. This is consistent with the data from [5; 31] which demonstrated that macroeconomic variables were statistically significant and their addition to the model enhanced its predictive power. In order to validate this hypothesis, we evaluated specifications of models with macroeconomic explanatory variables and without them.

Hypothesis H4. The gradient boosting model has the lowest probability of deviation of the predicted rating from the observed one by more than one step ($P\left(|\Delta| \geq 1\right)$. Among the considered models OLR will demonstrate the highest probability of deviation by more than one step. This corresponds to the evidence presented in the paper [27].

The smaller the dispersion of deviations of the predicted rating from the observed one, the ampler the possibilities of using the ICR model in order to assess the level of interest rates an MBC can expect to receive. It is related to the fact that interest rates may change significantly along with the rating change of more than one step [6].

Results and Discussion

Table 3 presents the results of forecasting MBC credit ratings by applying the abovementioned models. For the purpose of comparability, we submit the results of credit rating prediction using the "naive model", i.e. a randomly obtained value of an MBC credit rating using a random number generator. In order to evaluate the predictive power, we applied multiclass classification models assessment metrics [39]. The predictive power metric (Accuracy) evaluates the correlation between the correct forecasts of the rating and the general number of assessed ratings. The modified accuracy evaluates the correlation between the number of forecasts with the maximum error of one rating and the general number of observations. The completeness metric (Recall) evaluates the model's capability to select the correct rating, and the Precision metric measures the positive results defined accurately from the total number of predicted results in the positive grade and assesses the model capability to distinguish a correct rating from other ratings. The F1 Score metric evaluates the harmonic mean value of predictive accuracy. The Kappa Accuracy metric indicates the ratio of the difference between the probability of the correct model classification and the probability of a random correct classification to the probability of a random wrong classification. Finally, the Akaike information criterion (AIC) indicates a relative order of the compared models: the smaller the indicator, the better the model from the point of view of its predictive power.

Table 3. Results of the models' evaluation

Model	Accuracy, %	Modified Accuracy, %	Kappa Accuracy, %	McFadden R^2	AIC	Precision, %	Recall, %	F1 Score, %
The model that accounts for the time factor (70%/30%) and macrovariables								
Random forecast	7.63	12.70	–1.57	–	–	5.88	5.53	14.96
OLR	22.88	41.52	14.92	22.33	3174.00	18.40	19.40	32.68
RF	37.29	46.61	31.15	–	–	45.04	37.35	41.29
GB	39.01	50.54	32.59	–	–	39.74	36.230	40.26
The model that does not account for the time factor, but macrovariables								
Random forecast	9.00	16.85	–0.20	–	–	4.16	4.66	12.37
OLR	26.97	39.32	18.23	22.45	2924.00	36.72	20.51	37.32
RF	47.75	55.61	42.24	–	–	58.99	50.06	55.80
GB	48.88	57.30	43.65	–	–	53.74	47.57	52.54
The model accounts for the time factor (70%/30%), but does not account for macrovariables								
Random forecast	7.63	12.70	–1.57	–	–	5.88	5.53	14.96
OLR	23.73	41.52	15.61	20.8	3220	20.37	20.41	33.94
RF	45.76	51.69	40.16	–	–	52.49	45.53	47.02
GB	40.11	55.49%	33.75%	–	–	39.57	38.10	40.32
The model that does not account for the time factor or macrovariables								
Random forecast	9.00	16.85	–0.20	–	–	4.16	4.66	12.37
OLR	25.28	38.58	16.23	0.209	2964	27.30	19.20	34.39
RF	50.56	64.04	45.33	–	–	56.79	52.83	55.99
GB	47.21	53.04	44.75	–	–	53.17	49.63	54.01

H1 was partially confirmed. The GB and RF models demonstrated a higher quality than the OLR model by all accu-

racy indicators. Apart from that, all models significantly surpassed the random (naïve) forecast. However, the GB model was not better than the RF model in terms of several accuracy indicators. It may be due to the fact that when an ensemble is formed, each model uses different techniques (see section 1.2). In our unbalanced sample with the observations from different countries over 11 years the expected model error should be unpredictable and the GB model should agree with the RF model results. However, further research is necessary to analyze the obtained differences.

H2 was confirmed. A random division of data into the training and test samples ensured higher model accuracy (according to all indicators except the Modified Accuracy metric for OLR). A random division into the training and test samples had a similar distribution into rating grades, resulting in more accurate forecasts. On the contrary, separation of data on the basis of the time factor increased the imbalance in the rating distribution by scores which had been initially present in the sample (Figures 3 and 4).

H3 was not confirmed. Addition of macroeconomic variables did not enhance the predictive power of the models. On the contrary, it made the results worse. This conclusion was confirmed by analysis of diagrams of variable information significance in the GB and RF models (Figures 5 and 6). This may be due to the fact that international rating agencies trying to provide consistency of rating scores used the "skip-cycle" approach and evaluated the constant component of MBC's credit risk. However, as long as our conclusion disagrees with conclusions of other research papers [5; 31], it is necessary to study the obtained result further.

H4 was confirmed partially. In the GB model. modified accuracy is the highest indicator in all model specifications except for the model that does not account for the time factor or macrovariables. In its turn, in the OLR model the modified accuracy indicator is the lowest one in all model specifications. Analysis of obtained differences in modified accuracy for the GB and RF models when applying various sample creation methods requires further research. Nevertheless, in our opinion, the gradient boosting model is more promising for building the ICR model in order to evaluate the level of interest rates an MBC may count on.

Figure 3. Distribution of predicted ratings averaged among the models according to levels for the sample with regard to the time factor (leaving out macrovariables)

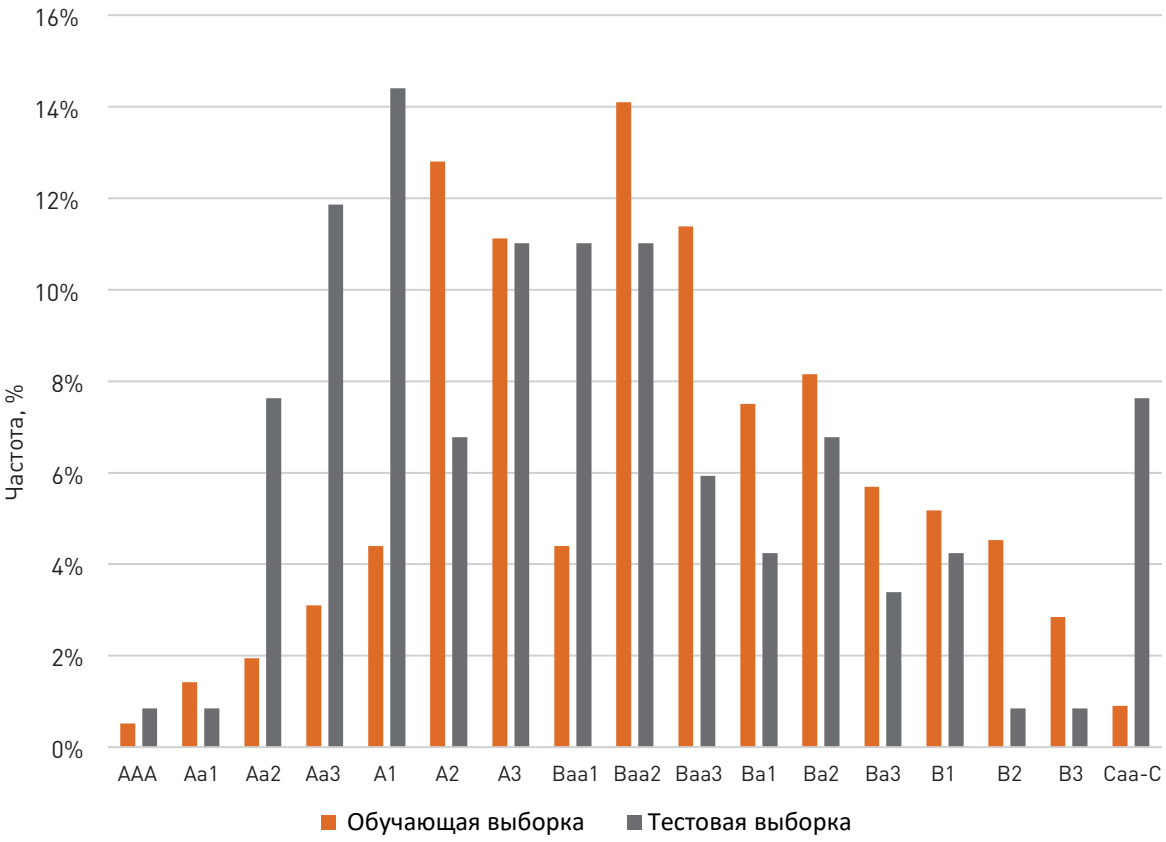


Figure 4. Distribution of predicted ratings averaged among the models according to levels for the random sample that accounted for the time factor (leaving out macrovariables)

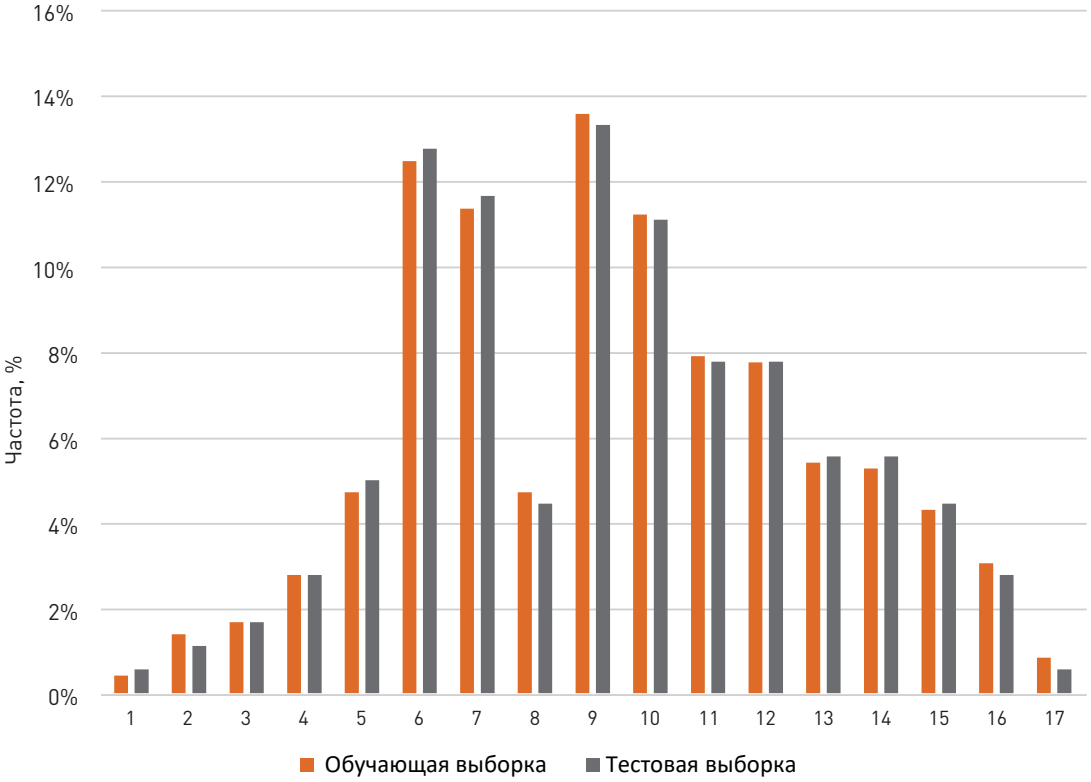
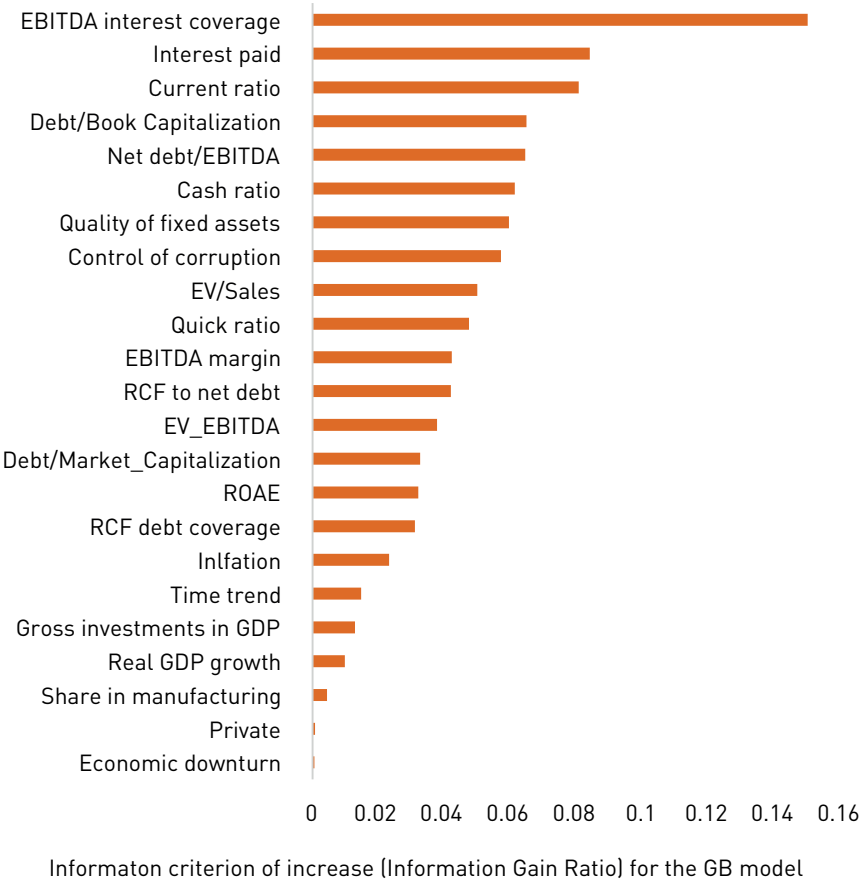
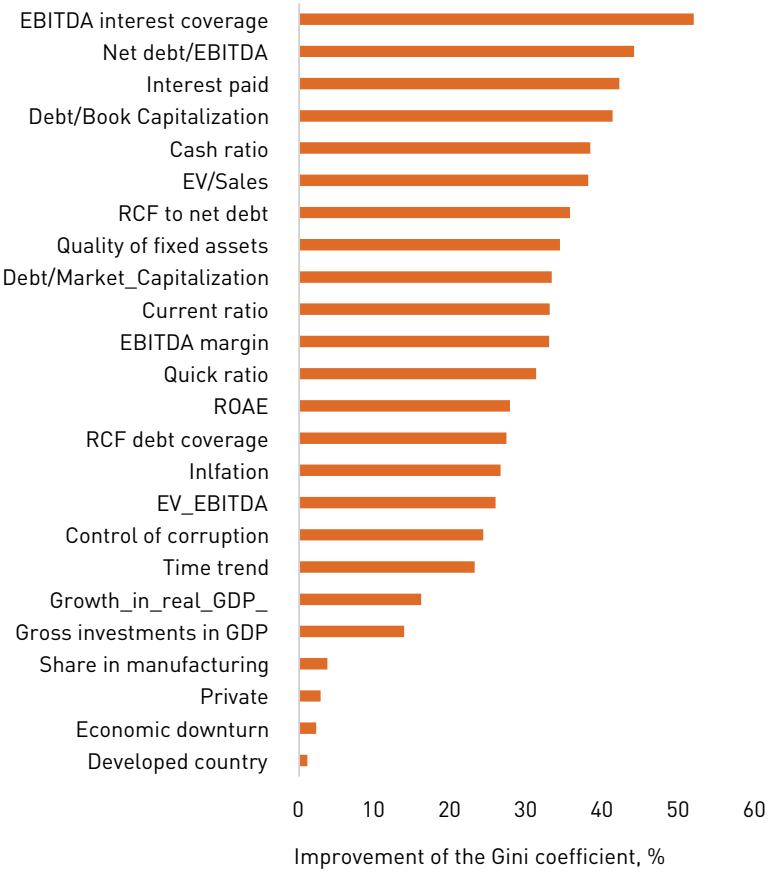


Figure 5. Information significance of explanatory variables in the GB model



Source: [36].

Figure 6. Influence of individual explanatory variables on the Gini coefficient increase in the random forest model (RF)



Conclusion

In this paper we compared the predictive power of empirical models of logistic regression and machine learning models for modelling the internal credit ratings of machine-building companies. Random forest and gradient boosting were used as machine learning models. The objective is of relevance because, on the one hand, MBCs' credit risks are still increasing and, on the other hand, just a few MBCs have a public credit rating. The paper filled the gaps in literature in the following ways: 1) use of explanatory indicators that take into consideration the specific character of the machine-building industry to the greatest extent; 2) use of the sample for a significant period of time that covers the whole credit cycle; 3) adding companies from the developed and emerging economies to the sample. The results showed that the predictive power of machine learning models is almost twice as high as the predictive power of ordered logistic regression and the share of predicted ratings, which deviate from the actual ones by more than one step is low. Therefore, use of machine learning models may have a wide practical application for building internal credit ratings of machine-building companies. Apart from that, we've discovered that a random division into the training and test samples enhanced the models' predictive power when compared to a division according to the time factor.

However, we failed to prove that addition of macroeconomic indicators to the model as explanatory variables enhances its predictive power. Therefore, in future studies it is necessary to perform additional testing of the effect of adding macroeconomic factors. Another line of research is the evaluation of the influence produced by the addition of non-financial indicators to model specification on its predictive power. The non-financial factors comprise the factors which define MBCs' competitive advantages in the target markets, operational performance indicators, knowledge capital efficiency indicators and MBC corporate governance efficiency indicators. Finally, a separate line of research may be represented by comparison of various sets of explanatory variables in order to improve the predictive power of CR assessment models from different industries, such as: oil and gas industry, metalworking and mineral industry, chemical industry, automobile construction etc.

Acknowledgements

The paper was written as a part of the work performed by the Group on Research of the School of Finance of the Faculty of Economic Sciences of HSE Banking Sector Innovations, its Financial Soundness and Prudential Regulation. The authors are grateful to Stepan Barkhatov, Elina Agaeva and Vladimir Lozovoy, students of the Faculty of Economic Sciences of HSE for help in collecting data and active involvement in building models and analyzing results.

References

1. Liao Y., Loures, E., Deschamps, F., Ramos, L.F. Past, Present and Future of Industry 4.0 – a Systematic Literature Review and Research Agenda Proposal. International Journal of Production Research. 2017; 55 (12)
2. Karminsky A.M., Peresetsky A.A. Rejtingi kak mera finansovyh riskov. Evolyuciya, naznachenie, primenenie. Zhurnal Novoj ekonomicheskoj associacii. 2009; 1-2
3. Karminsky A.M., Polozov A.A. Enciklopediya rejtingov: ekonomika, obshchestvo, sport. Forum; 2016.
4. Langohr H., Langohr P. The Rating Agencies and their Credit Ratings: What They Are, How They Work and Why They Are Relevant, John Wiley & Sons, Inc., Hoboken, New Jersey; 2008.
5. Karminsky, A.M. Peresetsky A.A. Modeli rejtingov mezhdunarodnyh agentstv. Prikladnaya ekonometrika. 2007; 1(5)
6. Karminsky, A. M. Kreditnye rejtingi i ih modelirovanie. Izd. dom Vysshej shkoly ekonomiki; 2015
7. Beaver, W. Financial Ratios as Predictors of Failure. Journal of Accounting Research. 1966; 4
8. Altman E.I. Financial ratios, discriminant analysis and the prediction of corporate bankruptcy. Journal of Finance. 1968; 23
9. Martin, D. Early Warning of Bank Failure: A Logit Regression Approach. Journal of Banking and Finance. 1977; 1, 249-276
10. Ohlson, J. A. Financial Ratios and Probabilistic Prediction of Bankruptcy. Journal of Accounting Research. 1980; 18, 109-131
11. Ederington, L. Classification models and bond ratings. The financial review. 1985; 20
12. Blume, M., Lim F., MacKinlay A. C. Thee declining quality of US corporate debt: Myth or reality? Journal of Finance. 1998; 53
13. Amato, J., Furfine C. Are credit ratings procyclical? Journal of Banking & Finance. 2004; 28
14. Ashbaugh-Skaife, H., Collins D., LaFond R. The Effects of Corporate Governance on Firms Credit Ratings. Journal of Accounting and Economics. 2006; 42
15. Demeshev B. B., Tihonova A. S. Dinamika prognoznoj sily modelej bankrotstva dlya srednih i malyh rossijskih kompanij optovoj i roznichnoj torgovli. Korporativnye finansy. 2014. T. 31. № 3. S. 4-22
16. Sermpinis G. Tsoukas S., Zhang P. Modelling market implied ratings using LASSO variable selection techniques. Journal of Empirical Finance 2018; 48
17. Kwon Y., Han I., Lee K. Ordinal pairwise partitioning (OPP) approach to neural networks training in bond rating. Intelligent Systems in Accounting, Finance & Management. 1997; 6: 23–40
18. Bellotti T., Crook J., Support vector machines for credit scoring and discovery of significant features. Expert Systems with Applications. 2009; 36 (2), p. 3302-3308
19. Davis, R. H., Edelman, D. B., & Gammerman, A. J. Machine-learning algorithms for credit-card applications. IMA Journal of Management Mathematics. 1992; 4(1), 43–51
20. Zhou, S. R., & Zhang, D. Y. A nearly neutral model of biodiversity. Ecology. 2008; 89(1), 248–258
21. Frydman, H., Altman, E. I., & Kao, D. L. Introducing recursive partitioning for financial classification: The case of financial distress. The Journal of Finance. 1985; 40(1), 269–291
22. Jensen, H. L. Using neural networks for credit scoring. Managerial Finance. 1992; 18(6), 15–26
23. West, D. Neural network credit scoring models. Computers & Operations Research. 2000; 27(1), 1131–1152
24. West, D., Dellana, S., & Qian, J. X. Neural network ensemble strategies for financial decision applications. Computers & Operations Research. 2005; 32(10), 2543–2559
25. Huang Z., Chen H., Hsu C., Chen W., Wu S. Credit rating analysis with support vector machines and neural networks: a market comparative study. Decision Support Systems. 2004; 37
26. Kumar, K., Bhattacharya, S. Artificial neural network vs linear discriminant analysis in credit ratings forecast: a comparative study of prediction performances. Review of Accounting and Finance. 2006; 5, 216–227
27. Chopra F., Bhilare P. Application of Ensemble Models in Credit Scoring Models. Business Perspectives and Research. 2018; 6 (4)
28. Wang, G., & Ma, J. Study of corporate credit risk prediction based on integrating boosting and random subspace. Expert Systems with Applications. 2011; 38(4), 13871–13878
29. Balios, D., Thomadakis, S., Tsipouri, L. Credit rating model development: An ordered analysis based on accounting data. Research in International Business and Finance. 2016

30. Bhojraj, S., P. Sengupta. Effect of Corporate Governance on Bond Ratings and Yields: The Role of Institutional Investors and Outside Directors.Journal of Business. 2003; 76(3), 455 – 475

31. Karminsky A. M. Metodicheskie voprosy postroeniya konstruktora dinamicheskih rejtingov. Vestnik mashinostroeniya. 2008

32. Saitoh, F. Predictive modeling of corporate credit ratings using a semi-supervised random forest regression. IEEE International Conference on Industrial Engineering and Engineering Management. 2016; 429-433

33. Grilli, L., Rampichini, C. Ordered Logit Model. Encyclopedia of Quality of Life and Well-Being Research. 2014; p. 4510-4513

34. Internet-resurs www.moodys.com

35. Biau, G. Analysis of a Random Forests Model. The Journal of Machine Learning Research. 2012; 98888, 1063–1095

36. Natekin A., Knoll A. Gradient Boosting Machines. Frontiers in Neurorobotics. 2013; 7 (21)

37. Senaviratna, N. A. M. R., Cooray A., T. M. J. Diagnosing Multicollinearity of Logistic Regression Model. Asian Journal of Probability and Statistics. 2019; 5(2), 1-9

38. Abdi, H. and Williams, L.J. Principal Component Analysis. Wiley Interdisciplinary Reviews: Computational Statistics. 2010; 2, 433-459

39. Hossin M. A Review on Evaluation Metrics for Data Classification Evaluations. International Journal of Data Mining & Knowledge Management Process. 2015; 5(2):01-11

Contribution of the authors: the authors contributed equally to this article.

The authors declare no conflicts of interests.

The article **was submitted** 16.01.2022; **approved after reviewing** 18.02.2022; **accepted for publication** 20.03.2022.

DOI: https://doi.org/10.17323/j.jcfr.2073-0438.16.1.2022.113-135
JEL classification: G30, G32

Cash Balance Management in Innovative Companies

Mariia Zarva
Financial Controller, Surgut Transshipment LLC, Moscow, Russia,
zarvamasa@yandex.ru, ORCID

Abstract

Since the 1980s, innovative companies all over the world have been holding a substantial cash balance on their books due to transactional, preventive, agency, tax-related and macroeconomic motives and by limitations in capital availability due to information asymmetry. Our research examines the determinants that influence the analysis of cash holdings of high-tech and non-high-tech companies.

Financial information for 38,386 unique companies was obtained from the 2009–2017 Compustat database. The final sample version comprised 12,083 companies, of which 2,909 were innovative. We used the panel regression method, selecting the appropriate calculation model and a number of proxy variables.

Our research confirmed the existence of innovative companies' significant cash holdings. Adding a macroeconomic factor variable (GDP growth) to the research model was justified for innovative companies only. In spite of the insignificant impact of GDP, increased GDP growth resulted in a decreased cash ratio for innovative companies. The authors also reveal the insignificance of R&D expenditures for innovative companies and prove that ranking companies by the amount of R&D expenditures and using this variable as innovation proxy was inexpedient. In addition, the authors confirm a positive relationship between growth opportunities, company size and cash ratio and a negative relationship between dividend payout and the amount of cash holdings.

An understanding of the reasons for cash accumulation facilitates prudential management of cash holdings in companies. This paper contributes new evidence to the study of corporate cash holding, focusing specifically on innovative companies, which have not been examined separately in the past.

Keywords: cash holding, high-tech companies, non-high-tech companies, R&D expenditures, patents

For citation: Zarva, M. Cash Balance Management in Innovative Companies. *Journal of Corporate Finance Research*. 2022;16(1):113-135. https://doi.org/10.17323/j.jcfr.2073-0438.16.1.2022.14-37

Introduction

Over a prolonged period from the 1980s and to the present day, cash has been one of the principal items on the balance sheets of companies, in particular, American ones. According to Bates, Kahle and Stulz [1], the average ratio between cash and assets of the industrial US enterprises listed by the above authors increased from 10.5% in 1980 to 23.2% in 2006, while Sanchez and Yurdagul [2] noted a fourfold increase of cash funds held by American companies in 2011 in comparison to 1995. Moreover, a growth of cash holdings was observed in non-American companies. For instance, research by Daher [3] revealed that the ratio of cash to assets of private companies in Great Britain also almost doubled between 1994 and 2005, and a similar trend was observed in many research papers all over the world.

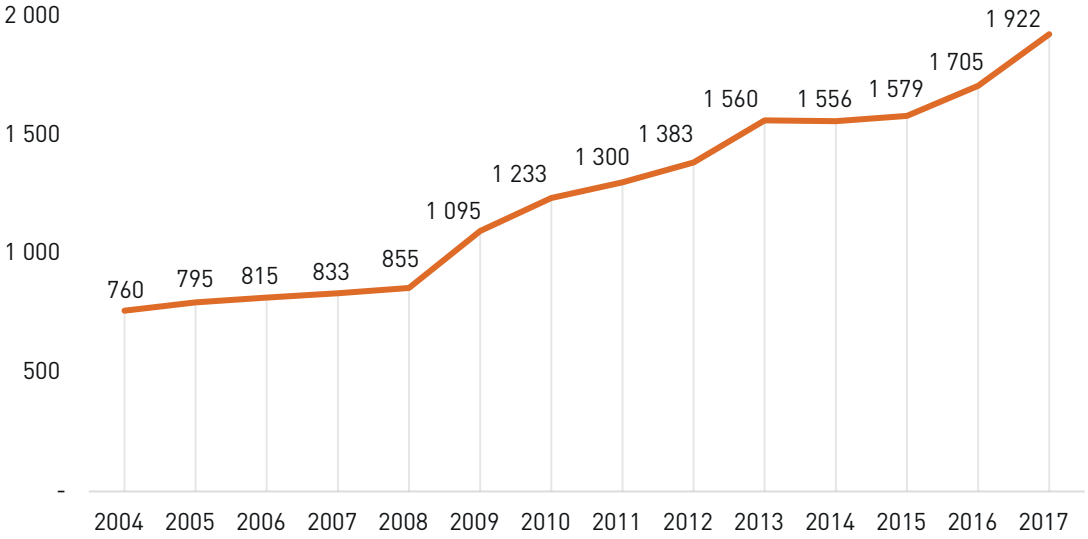
The amount of corporate cash continued growing between 2004 and 2017; cash holdings of non-financial companies across the globe increased almost fourfold from $2.8 trillion to $8.3 trillion.

As at the end of 2016, according to Standard & Poor's Global Ratings (S&P) [4], American non-financial companies held $1.9 trillion in cash, and in 2017, according to Bloomberg, this figure reached a record amount of $2,3 trillion. The first 25 companies (top 1) in S&P's rating of non-financial corporate borrowers, held more than a half of the total amount of cash in 2016.

Increase of the cash holdings level of American companies is confirmed by Compustat data for 1,797 American non-financial companies, although according to this database, cash holdings levels are slightly lower than the ones provided by information agencies (Figure 1). It may be related to incomplete data about public companies in Compustat and to the absence of data on private companies that also hold cash.

According to Compustat data, the share of American companies in global cash holdings as at the end of 2016 was 23%.

Figure 1. Amount of cash held by American public companies in 2004-2017, billion US dollars



Source: Compiled by the author based on Compustat data on 1,797 American companies.

In 1980–1990s an increase in cash holdings occurred partly due to the fact that many financially unstable companies went public [1]. After the crisis of 2008, the next IPO booms occurred (in 2010 and 2014) [2; 3]. They involved the soaring high-tech sector, which could have also partly caused an increase in the amount of cash [4], but obviously not to the present extent. What could trigger the sharp increase in the amount of cash holdings?

Studies demonstrate that there is a wide range in the amount of cash held by industry sector. In particular, a disproportionately large amount of cash is accumulated in high-tech sectors. As early as in 2009, research by Bates et al. [1] emphasized that high-tech companies had the biggest ratio of cash holdings to assets. According to Global Finance [5], in 2017 the largest American tech giants, such as Microsoft, Google and Apple accounted for just over $400 bln in cash, while the share of the top 10 companies holding the most cash in the world in the same year equaled approximately $750 bln. The top 10 companies were closest to the high-tech industry and electronics.

After a study of an international company sample, Stulz et al. [6] revealed that multinational corporations with a high R&D level held the largest cash balance. Lyandres et al. [7] assert that exceptionally innovative companies that invest significantly in R&D and patents increased the amount of cash in 1980s–2000s. Subsequently, Graham et al. [8] noted that in the 20th century cash holdings were approximately at the same level in all industries, in the 21st century there was a growth of cash holdings in high-tech and pharmaceutical sectors. The authors believe that the reason is the change in the companies' characteristics and their going public. These results suggest that industry-related characteristics are a key factor that defines the amount of cash holdings in corporations. This result is consistent with the conclusions

made by Booth et al. [9], who proved that cash-to-assets ratio grows due to the change in characteristics of high-tech companies.

The existing scientific literature defines companies' potential motives for cash accumulation. These include transactional, preventive, agency, tax-related and macroeconomic motives. One of the key reasons is limited capital availability due to information asymmetry, which leads high-tech companies to save more cash [10]. However, high-tech companies' motives have not been fully disclosed. Further we consider the determinants that influence the analysis of cash holdings of high-tech and non-high-tech companies.

Literature Review

Definition of an Innovative Company

Innovative companies (high-tech) is a term describing firms and industry sectors which manufacture or use advanced technologies in their business model.

The dominant feature of innovation is its use by a certain enterprise for the first time. This definition was provided by the US Bureau of Economic Analysis [11]; however, it describes the US digital economy, it is unique and does not replace the innovation concept.

The most popular definition of an innovative company is formulated in the OECD and EUROSTAT publication Oslo Manual. It points out that "an innovative firm is one that has implemented an innovation during the period under review" [12, p. 32]. Innovation is understood as "the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace organization or external relations" [12, c. 31]. Companies should receive the status of innovative using the criteria that distinguish high-tech companies from low-tech firms and reveal the key characteristics of the companies of the former type.

The first criterion for the selection of innovative companies used in literature is the absence or presence of R&D expenditures and their intensity. Some researchers define a company's innovativeness on the basis of presence/absence of R&D expenditures [13], intensity (amount) of research and development expenses [14; 15] and number of employees involved in research and development [16]. The biggest portion of these expenses is often comprised by salaries of highly educated engineers, scientists and researchers because companies prefer to retain the professionals who create the company's science and technology base, which, in its turn, generates income for the company [13].

R&D expenditures are fundamental for the survival and thriving of an innovative company. However, this approach is not entirely correct for two reasons: some companies do not disclose R&D expenditures or fail to mention them in their financial statements; studies may not be performed on an annual basis, thus, one (more innovative) company may have no R&D expenditures in the current period and, on the contrary, another (less innovative) company may incur significant expenses for research and development in the period under review.

The paper by Begenau et al. [17] proved the existence of a trend in American innovative companies towards developments that are less profitable, but have greater growth potential. According to PwC [21], the intensity of R&D expenditures does not guarantee financial success because there is no long-term correlation between the amount a company spends on innovation efforts and its overall financial performance. Only the way a company uses the money and other resources to create products and services for customers is of great importance.

The second criterion is based on the annual ratings of innovative companies [20]. One may use the available annual ratings of innovative companies published by such recognized resources as The Boston Consulting Group. "The most innovative companies 2018" – top 50 [19] and PricewaterhouseCoopers "The 2018 Global Innovation 1000 study" [18], Forbes "The World's Most Innovative Companies" – top 100. As per BCG [19], since 2014 the following four lines of innovation have gained significance: big data analysis, acceleration of new technology implementation, mobile applications and digital design. See the top 10 innovative companies according to the three abovementioned ratings in Table 1.

Table 1. Top 10 innovative companies in 2018

Number	BCG	PwC	Forbes
1	Apple	Amazon.com	ServiceNow
2	Alphabet (Google)	Alphabet (Google)	Workday
3	Microsoft	Volkswagen Aktiengesellschaft	Salesforce.com
4	Amazon.com	Samsung	Tesla
5	Samsung	Intel	Amazon.com
6	Tesla	Microsoft	Netflix
7	Facebook	Apple	Incyte

Number	BCG	PwC	Forbes
8	IBM	Roche Holding AG	Hindustan Unilever
9	Uber	Johnson & Johnson	Naver
10	Alibaba	Merck & Co.,	Facebook

Sources: BCG, PwC, Forbes.

One may note that while BCG and PwC ratings partially overlap (five out of ten companies are present in both ratings), the Forbes rating is in stark contrast with the above two, with Amazon.com being the only company included in all ratings. This is due to the use of different methodologies for creating the rating. Forbes corporate ratings rank companies by innovation premium: the difference between their market capitalization and the net present value of cash flows from existing businesses (on the basis of a patented Credit Suisse HOLT algorithm). The annual rating of the most innovative companies by BCG is based on a poll of senior executives by choice of respondents and evaluation of three financial indicators for three years: total shareholder returns (TSR), revenue growth and margin increase. The PwC [21] rating is comprises the companies that have spent the largest amounts on research and development within the last financial year, adjusted for the industry sector and amortization of capitalized costs. The use of annual ratings created by large agencies apparently limits the number of studied companies.

The third criterion is patents. Patents and their citation level are established in literature as reliable and significant indicators of innovation efficiency [23]. In early studies, research and development results were used as an approximate indicator of innovation efficiency. The variable represented the number of patents [24–26]. However, it was proven that the number of patents does not provide an accurate representation of innovative efficiency because it does not demonstrate the importance of patents. At the same time, a close relationship was discovered between the indicators based on patent citation and innovation costs [26]. Evaluation on the basis of the number of patent citations was one of popular ways to measure innovation efficiency [27–33].

Finally, the fourth criterion is the industry sector. It is a generic criterion for defining innovative companies. Its advantage lies in the fact that there are multiple industry classifiers among which one may specifically choose the ones with the presumably greatest number of high-tech companies. Usually, researchers choose Telecommunication, Health Care (Biotechnology and Pharmaceuticals, Medical Equipment) and companies engaged in the semiconductor industry, manufacturing of machinery, software, digital architecture and technology services.

Papers dedicated to corporate finance use the following international code classifiers:

- SIC [34–36];
- NAICS [37];
- GICS [38];
- Internal classifiers of systems Capital IQ [39], Reuters (RIC codes) and Bloomberg (BICS codes).

Research by Kile et al. [40] compares the quality of SIC, NAICS and GICS classifiers in regard to completeness and sufficiency and defines the codes containing a greater percentage of innovative companies recommended by the authors in order to create a sample of high-tech firms or intentionally selected high-tech industry sectors. Furthermore, the research is based on the sample by Kile et al. [40] of 3-digits SIC codes related to high-tech companies. At the same time, one has to bear in mind that the SIC-code sample is not free from shortcomings because affiliation with a high-tech industry does not guarantee that the company itself is really an innovative one, and vice versa, a low-tech industry may comprise high-tech companies [40; 41].

Being aware of all possible limitations of this approach, one has to take into consideration the intensity of R&D expenditures and companies' growth opportunities. This will help to draw a clearer line between company types [35].

Distinctive Features of Innovative Companies

High-tech companies have the following specific characteristics. First, initially high-tech companies have **larger cash holdings** than classic industrial companies [1; 42]. Second, it influences the **choice of the funding source**. Himmelberg et al. [43] presume that small high-tech companies, as a rule, use internal financing to maintain R&D and capital expenditures. Guiso [44] proves that it is more difficult for high-tech companies to obtain access to credits than for low-tech firms. This view is substantiated by the research conducted by Carpenter et al. [45] and Booth et al. [9]. They conclude that small high-tech companies prefer to raise equity capital instead of using debt instruments. This is due to the fact that the innovation development sphere is extremely unstable [7] from the effectiveness viewpoint, while external concerned parties cannot observe the situation and reasonably expect future results, thus aggravating *information asymmetry*. Besides, in view of their specific nature high-tech companies often have insufficient security for a loan [46]. This results in more expensive external financing for innovative companies [47] and their greater dependence on internal and equity financing than on debt financing. It is especially apparent in young innovative companies [9] and small high-tech companies [48]. Third, it has been proven that innovative companies have shifted to developments that are less profitable but have greater growth potential [17].

Financial literature defines companies' four main motives for holding cash. In this section we offer a literature review concerning these issues and analyze the motives that may influence corporate cash.

Transactional Motive

For the first time this motive was mentioned in the paper by Keynes [49]. Classic models assess the optimal levels of cash because companies face expenses related to the conversion of a non-monetary asset into cash [50; 51]. Due to economy of scale, larger companies have lower operating costs, which is why they also have a smaller amount of cash [1; 51]. Drobetz et al. [52] considered the cash holdings of 156 Swiss non-financial companies for 1995–2004. They revealed a strong negative relationship between the amount of tangible assets and cash correlation. This points out that companies are prone to accumulate smaller amounts of cash if they have large high liquidity assets that provide an easy way to obtain cash. Therefore, such companies minimize alternative liquidity costs. Besides, Drobetz et al. [52] also discover a substantiation of the fact that large companies experience economy of scale when issuing securities and, consequently, have less cash. These results correspond to the research results obtained by Mulligan [53]. High-tech companies are mainly smaller than traditional sector firms, they have less non-monetary current assets (which may be an analogue of cash). For this reason, in order to confirm the transactional motive, one has to expect less influence of the economy of scale on cash holdings in innovative companies [54].

The variables proposed for evaluating the motive are company size, non-monetary liquid assets. In order to assess liquidity, we used two variables: net working capital for the working capital requirement (WCR) and net liquidity balance (NLB). These indicators were developed by Shulman et al. [55], who used them to study working capital. WCR is measured in order to evaluate working capital management, and NLB – to evaluate capital distribution.

Preventive Motive

The second motive for a company to store cash is to hedge the risks related to possible future shocks. Therefore, we expect companies with more risky cash flows and less access to capital market to have more cash [56]. This theory also suggests that firms with higher growth rates and better investment opportunities will store more cash because their expenses in case of financial difficulties will be higher. Numerous studies confirm this positive relationship between investment opportunities and cash holdings [42; 54; 56–60]. Almeida et al. [61] revealed that companies without financial restrictions are less sensitive to cash flow changes and increase their cash holdings to a smaller extent than companies facing such restrictions. Han et al. [62] continue their research on a sample of companies traded in the USA in 1997–2002 and establish that a company with limited finances, unlike a company with unlimited funds, builds up its monetary holdings as a response to an increased cash flow volatility. Opler et al. [56] and Ferreira et al. [57] also substantiate the volatility of cash flows and cash holdings.

Due to the fact that innovative companies usually have more risky cash flows, debt financing is costlier for them, and investors demand a higher risk premium, high-tech companies in general are more financially restricted than low-tech companies, consequently, they accumulate more cash.

Biotechnology and medical equipment should be mentioned specially as an industry with extremely high investment opportunities and greatest risks. According to BCG, up to 90% of research expenses are wasted yielding no results because a medicines may have no effect and its development ceases, thus increasing the need for significant financing [63].

Ongoing development and high capital expenditures are characteristic of bio-industry and pharmaceutical industries, as well as in the manufacturing of medical equipment and devices because R&D expenditures and capital investments are the main preconditions for the viability of these companies. For this reason, companies from these industries in particular need access to capital market.

One of possible reasons for accumulation of cash is its investment into more promising projects, which is confirmed by papers by Opler et al. [56] and Bates et al. [1], or to even out R&D expenditures [13]. Apart from that, the importance of cash availability for increased probability of obtaining patents was proven [64].

The following variables are used to assess the preventive motive: cash flow volatility, size of tangible assets, dividend payouts, corporate financial leverage, R&D expenditures; selling, general and administrative expenditures (SG&A); capital expenditures (CapEx), Market-to-Book indicator, Springate Z-score – bankruptcy probability indicator: if $Z < 0.862$, an enterprise is classified as bankrupt (taken as an analogue of Altman Z-score used in the paper by García-Teruel et al. [59] because it is equal in accuracy to Altman Z-score and sometimes surpasses it [65; 66]); debt repayment structure.

Agency Motive

The third motive for cash holdings is an agency conflict between company owners and managers concerning distribution of internal capital caused by different aims of the concerned parties. The free cash flow theory states [67] that in the absence of good investment opportunities managers are more likely to create cash balance than increase dividend payments to shareholders because it provides them with an opportunity to get greater control over the company. Papers by Dittmar et al. [68] and Ferreira et al. [57] revealed that companies operating in the countries with minor agency conflicts (investors are well-protected) have less cash.

Apart from conflicts between company management and shareholders, there may be a clash of interests between a company's minority and majority shareholders. Major shareholders may take advantage of their position and gain more benefits than minority shareholders. As long as these

shareholders may obtain cash more easily, it is expected that these companies will have greater cash balance [69]. The paper by Bates et al. [1] also substantiated the agency theory.

Opposite results were obtained in the research conducted by Harford et al. [58] – higher cash holdings were observed in companies with a weaker corporate governance. The reasons for that were explained as follows: first, the management increased cash holdings to a smaller extent out of fear of disciplinary sanctions, which resulted in the re-assignment of money to capital expenditures (CapEx) and purchases. Second, a large cash balance could attract the attention of external investors.

Other studies also do not confirm the influence of the agency conflict on cash holdings [54; 56].

Tax-Related Motive

Another motive for the increase of cash holdings is tax expenses. Companies earning income in other countries may face negative tax consequences related to such income repatriation. Repatriation of income from branch offices in the countries with a lower tax rate results in higher tax expenses and, consequently, these branch offices have higher levels of cash than others. Falkeunder at al. [70], as well as Foley et al. [42] earlier, confirmed that US corporations threatened by a high repatriation tax have more cash.

This theory forecasts that multinational companies, especially innovative ones, will have a larger cash balance because it makes it easier to redistribute innovations, patents and R&D expenditures, while it is more difficult to trace the income gained from patents and innovations [42].

Macroeconomic motive

There are several papers dedicated to the study of the influence of macroeconomic factors on cash holdings. One of significant studies in this sphere is the paper by Graham at al. [8], where they prove that the use of only financial company characteristics is insufficient to study the influence of determinants on cash holdings. Therefore, they introduce proxy variables of macroeconomic factors: gross domestic product (GDP) growth rate and interest rate sensitivity. Research by Azar et al. [71] uses the T-bill rate as a variable for macroeconomic factors, which turned out to be an important factor in defining the level of corporate cash balance. Change of profitability influenced innovative companies to a smaller extent than classic industry companies because innovative companies had more saved cash as long as they preferred to save money for future investment opportunities and needed cash for immediate operations with customers and to a lesser extent – with suppliers. These companies had an opportunity to redistribute cash between interest-bearing and non-interest-bearing accounts in a better way. Research by Booth et al. [9] also confirms these conclusions.

On the basis of the literature review above, we may suggest the following hypotheses:

H1: *An increase in liquidity decreases cash holdings.*

H2: *As GDP grows, cash holdings decrease. The influence of this factor in innovative companies is less than in non-innovative ones.*

H3: *An increase in company size and R&D expenditures results in increased cash holdings.*

H4: *Innovative companies are sensitive to changes in cash flow, therefore, the higher the cash flow volatility, the more cash a company has.*

Data, Methodology and Descriptive Statistics

Data sample and formulars for indicators calculation

Financial information on companies was obtained from the Compustat database for the period of 2009–2017. We uploaded a total of 38,386 unique companies. Similarly to Castro et al. [35], we excluded companies with SIC code 4900–4999 (government-controlled ones) from the sample.

As in paper by García-Teruel at al. [59], we updated the sample, eliminating companies with data errors or lost values from the sample. In case of absence of data on R&D, CapEx or dividend payout, we assumed that the value for the company equals zero. In particular, it was necessary that variables such as total assets, fixed assets, proceeds and cash were positive [56; 59]. In order to calculate GDP growth rate, historical data was obtained from the online platform of the World Bank (https://www.worldbank.org/).

As a result of sample purging, 12,083 companies were left, 2,909 of them - innovative companies. Since we didn't have Compustat data concerning Market Capitalization, the data for this indicator was uploaded from Bloomberg only companies classified as high-tech in accordance with the BICS classifier: Telecommunication, Medical Industry and Technology. For this reason, the influence of the classic form of Market-to-Book ratio on cash holdings will be taken into consideration only for the complete sample and high-tech companies. As a result, the MtB_classic variable was calculated for 1,751 innovative companies and 300 non-innovative companies.

We calculated the required indicators on the basis of the uploaded financial information. See the indicator calculation formulas in Table 2.

Table 2. Variable calculation formulas

Item	Designation in the model	Variable calculation formula
Cash	Cash_ratio	$\frac{\text{Cash and marketable securities}}{\text{Total assets}}$
Company's growth opportunities	MtB_classic MtB_analogue	$\frac{BV_{assets} - BV_{equity} + MV_{equity}}{BV_{assets}}$ $\frac{Sales_{current\ year}}{Sales_{previous\ year}}$
Company size	FirmSize	$\ln(\text{Total Assets})$
Financial leverage	Lev	$\frac{\text{Long\_term debt} + \text{Short\_term debt}}{\text{Book value of assets}}$
Research and Development expenditures	RD	$\frac{R\ \&\ D_{expenditures}}{\text{Total Assets}}$
Selling, general and administrative expenditures	SGA	$\frac{SG\ \&\ A_{expenditures}}{\text{Total Assets}}$
Intangible assets	Intangibles	$\frac{\text{Intangible Assets}}{\text{Total Assets}}$
Capital expenditures	Capex	$\frac{\text{Capital expenditures}}{\text{Total Assets}}$
Cash flow amount	CashFlow	$\frac{\text{Pre}-\text{tax profits} + \text{Depreciation}}{\text{Sales}}$
Cash flow volatility	CF_volatility1 CF_volatility2	$\text{Stand.dev}\frac{Oper.CF_{-2nd\ year} + Oper.CF_{pr.year}}{2}$ Stand. dev of EBITDA for observed years
Debt repayment structure	Ldebt	$\text{Debt mat. structure} = \frac{\text{Long\_term debt}}{\text{Total debt}}$
Probability of bankruptcy	Springate_Score	$\text{Springate Z}-\text{Score}$
Liquidity	WCR_L1 NLB_L2	$\frac{WCR}{Sales}$ $\frac{NLB}{\text{Total Assets}}$
GDP growth rate	GDP_growth	$\frac{GDP_{current\ year} - GDP_{previous\ year}}{GDP_{previous\ year}}$

The following dummy variables were also added:

$$\text{DivPayout\_dummy} = \begin{cases} 1, \text{if a company pays dividends} \\ 0, \text{if a company doesn't pay dividends} \end{cases}.$$

$$\text{HightechbyKile\_dummy} = \begin{cases} 1, \text{if a compaby is innovative} \\ 0, \text{if a compaby is not innovative} \end{cases}$$

$$\text{R \& D\_dummy} = \begin{cases} 1, \text{if a company has RD expenditures} \\ 0, \text{if a company doesn't have RD expenditures.} \end{cases}$$

$$\text{Sector\_dum} = \begin{cases} 1, \text{if it is a pharmaceutical / biotech company} \\ 0, \text{if it is not a pharmaceutical company.} \end{cases}$$

$$\text{Country\_dum} = \begin{cases} 1, \text{if a company is in a developed country} \\ 0, \text{if a company is in an emerging country} \end{cases}$$

A company was considered a pharmaceutical one if it was classified under SIC codes 382, 384, 283, 873, 387.

Methodology Description

First, we started panel regression for the entire sample in order to see whether the selected determinants are significant or whether they make sense for the entire sample. Then we divided the sample into two parts: innovative and non-innovative companies and repeated the first step in order to define the correlation between cash and the chosen proxy variables for both types of companies. Then we assessed the pooled, random-effect and fixed-effect models. Then we chose the most appropriate calculation model on the basis of Breusch-Pagan, Haussman and Wald tests.

Let us consider the following model with regard to the restrictions of samples and variables described above:

$$\begin{aligned} \text{CASHratio} = {} & \beta_0 + \beta_1 \text{FirmSize} + \beta_2 \text{Lev} + \beta_3 \text{RD} + \\ & + \beta_4 \text{SGA} + \beta_5 \text{Intangibles} + \beta_6 \text{Capex} + \\ & + \beta_7 \text{CF\_volatility1} + \beta_8 \text{CF\_volatility2} + \\ & + \beta_9 \text{LDebt} + \beta_{10} \text{Springate\_Score} + \beta_{11} \text{WCR\_L1} + \\ & + \beta_{12} \text{NLB\_L2} + \beta_{13} \text{GDP\_growth} + \\ & + \beta_{14} \text{DivPayout\_dummy} + \\ & + \beta_{15} \text{HightechbyKile\_dummy} + \\ & + \beta_{16} \text{RD\_dummy} + \beta_{17} \text{Country\_dummy} + \\ & + \beta_{18} \text{Sector\_dummy} + \beta_{19} \text{MtB}_{\text{analogue}} + \\ & + \beta_{20} \text{MtB}_{\text{classic}} + \varepsilon. \end{aligned}$$

The dependent variable is the cash ratio; the other variables are grouped together in Table 3 according to the motives they explain.

Table 3. Motives explained by the variables:

Agency	Transactional	Preventive	Macroeconomic
Company size	Company size, liquidity	Company's growth opportunities, financial leverage, expenditures for R&D and SG&A, Capex, intangible assets, dividend payout, CF amount and volatility, debt repayment structure, probability of bankruptcy	GDP growth rate

Descriptive statistics

Descriptive statistics for all variables in the regression equation is presented in Table 4, while the descriptive statistics for the MtB_classic variable is provided only for high-tech companies.

Table 4. Descriptive statistics of all model variables except dummy variables

Variable	Obs	Mean	Std. Dev.	Min	Max
Cash_ratio	108747	.150919	.1360805	2.68e-06	.9970662
GDP_growth	108747	.0415977	.0916111	−.348707	1.188959
CashFlow	108747	.0635924	28.21666	−1556	8581.092
CF_volatil~1	108747	33.4242	411.9104	0	102452.9
Lev	108738	1.405031	103.7957	0	28137.43
Ldebt	108747	.3683848	.3340301	0	1
FirmSize	108747	5.598556	1.937406	−2.864704	13.77684
MtB_analogue	108747	1.45825	84.76837	.0000166	27610.88
RD	108747	.0117841	.0353209	0	1.709541
Capex	108747	.0467223	.0870893	0	22.90815

Variable	Obs	Mean	Std. Dev.	Min	Max
Intangibles	108738	.0462	.0848139	0	.8955983
NLB_L2	108747	-.0655604	.204252	−1.932836	5.162755
WCR_L1	108747	.9130113	139.5594	−118.8889	45508.19
SGA	108747	.1661718	.1835545	0	3.713348
Springate_~e	108747	.9124516	19.86528	−1510.584	6302.671
CF_volatil~2	108747	78.57044	485.3962	.0053287	15581.01
MtB_classic	26181	557.8765	8248.482	0	952288.1

Further we present a cash ratio description table (Table 5) for the first sample, which demonstrates that on average innovative companies do, in fact, havetwice as much cash holdings as low-tech companies and as companies in general in the whole sample in 2009–2017. This is consistent with the findings of the previous studies of corporate cash.

However, unlike in previous studies such as Bates et al. [1] and Sanchez at al. [2], it is impossible to confirm observations of a steep growth of the cash ratio indicator (Figure 2). It is, however, possible to notice that innovative and non-innovative companies in general follow the common trends of decrease/growth of cash ratio, but at initially different levels.

One may observe that the mean value of cash ratio across the sample grows over time - although the growth is unstable and slow – from 0.1483 in 2009 to 0.1559 in 2017. The cash ratio indicator reaches the peak value for the entire sample and for the breakdown by types of companies in 2016 and amounts to an average of 0.1572 for the entire sample. The data allows to conclude that the cash holding phenomenon still exists and has been stable over a long time.

Table 5. The mean cash ratio value across the whole sample and in the breakdown by high-tech and non-high-tech companies for 2009–2017

	Total Sample		High-tech		Non-high-tech	
Year	N	Mean	N	Mean	N	Mean
2009	12083	.1482705	2909	.212071	9174	.1280399
2010	12083	.1551042	2909	.2196665	9174	.1346321
2011	12083	.1480538	2909	.2116815	9174	.127878
2012	12083	.1450895	2909	.2102078	9174	.124441
2013	12083	.1467378	2909	.2153591	9174	.1249786
2014	12083	.1481327	2909	.2164534	9174	.1264688
2015	12083	.1536616	2909	.2228572	9174	.1317203
2016	12083	.1572429	2909	.2244783	9174	.1359231
2017	12083	.155978	2909	.2244708	9174	.1342594

Table 6. Mean value of cash ratio in the breakdown by developed and developing countries for 2009–2017

	Total Sample		Developed		Developing	
Year	N	Mean	N	Mean	N	Mean
2009	12083	0.148271	4637	0.150098	7446	0.147132
2010	12083	0.155104	4637	0.154349	7446	0.155575
2011	12083	0.148054	4637	0.151232	7446	0.146075
2012	12083	0.145089	4637	0.151878	7446	0.140862
2013	12083	0.146738	4637	0.1548	7446	0.141717
2014	12083	0.148133	4637	0.156577	7446	0.142874
2015	12083	0.153662	4637	0.160484	7446	0.149413
2016	12083	0.157243	4637	0.164135	7446	0.152951
2017	12083	0.155978	4637	0.163693	7446	0.151173

Figure 2. Cash ratio dynamics for the entire sample, innovative companies and low-tech companies in 2009–2017

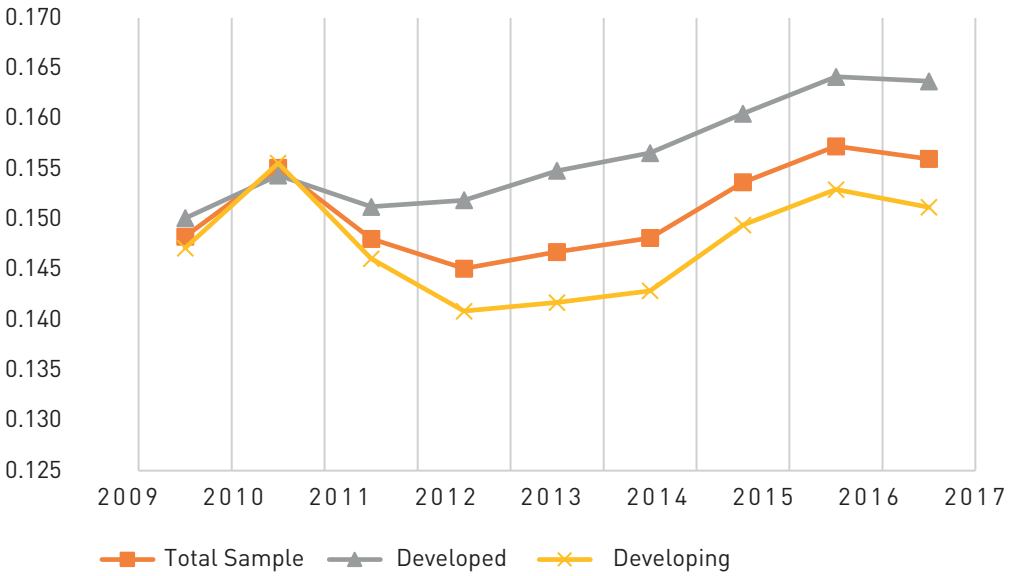


Table 6 presents mean values of cash ratio for emerging and developed countries. One may notice that the trend of cash ratio growth in the breakdown by developed/developing countries is preserved over nine years, at the same time, the difference of the mean value between cash ratio levels in developed and emerging countries in minimal. So, we can conclude that in general there isn't any relationship between the cash ratio mean level and the country type.

Table 7. Descriptive statistics of high-tech and non-high-tech companies

Indicator	Non-high-tech		High-tech	
Variable	Mean	Std. Dev.	Mean	Std. Dev.
Cash_ratio	.1298157	.118552	.2174717	.1635872
Sector_dummy	0	0	.2461327	.430765
Country_du~y	.3858731	.4868038	.3771055	.4846709
GDP_growth	.0424796	.0937058	.0388162	.0846078
CashFlow	–.0186727	10.53209	.3230287	54.38051
CF_volatil~1	34.47913	262.9168	30.0973	697.6782
Lev	1.27566	67.74268	1.813144	174.0222
Ldebt	.3776944	.3338205	.3390255	.3329962
FirmSize	5.729163	1.946793	5.186664	1.848034
Cash_ratio	.1298157	.118552	.2174717	.1635872
DivPayout_~y	.5471623	.4977738	.5596425	.4964395
RD	.0052734	.0152681	.0323167	.0623831
RD_dummy	.3703583	.4829036	.6895459	.4626884
Capex	.047791	.0534476	.0433522	.1499348
Intangibles	.0392533	.0742063	.068115	.1090082
NLB_L2	–.0878253	.191093	.0046554	.22723
WCR_L1	.5074767	23.34715	2.19193	281.3917
SGA	.1574245	.1774796	.193758	.1990179
Springate_~e	.9297205	22.71017	.8579914	3.556911
CF_volatil~2	84.443	515.1981	60.05037	375.6637
MtB_classic			557.8765	8248.482

Predictably, when analyzing mean values of variables in the breakdown by high-tech/non-high-tech companies, the mean level of R&D, SG&A and Intangibles was higher for innovative companies than for non-innovative ones. At the same time, for some reason the financial leverage of innovative companies was on average higher than for non-innovative ones, although the mean value of Ldebt was smaller (Table 7). The first explanation is that innovative companies have a greater deficiency of internal funds than low-tech companies and are forced to raise funds as the external market. But in this case, the obtained result contradicts the opinion that innovative companies will use borrowed funds to a lesser extent because they are expensive and difficult to obtain. The second explanation is more mathematical and is related to calculation of this variable: innovative companies simply have less assets than low-tech ones, consequently, the denominator is smaller. Therefore, with the same or even smaller amount of external financing, the mean variable for financial leverage records a higher level for innovative companies.

On average, the CashFlow variable has a negative value for low-tech companies. This means that companies from classic industries, unlike innovative ones, have problems with income. The sample was purged from companies with nonpositive proceeds, so we may see the influence of the numerator of this variable in the table.

Non-innovative companies showed a higher degree of cash flow volatility for both ways of calculation. A possible explanation is the sample bias towards low-tech companies in terms of quantity because there are over 9,000 non-innovative companies in the sample, while the number of high-tech companies is just over 2,000. Consequently, there is a greater variability of companies from classic industries in the sample.

Springate Z-score predictably shows that the mean value of bankruptcy probability for innovative companies is higher than for low-tech companies (an inverse relationship between the coefficient value and bankruptcy probability), which is due to a higher risk of failure of a company's operations.

We define the correlation level between regressors in order to eliminate the multicollinearity risk in the model to avoid an accidental omission of a potentially significant regressor. A strong relationship was revealed between the NLB_L2 variable and cash ratio – 0.762, between the MtB_analogue variable and WCR_L1 – 0.9941, between Sector_dummy and HightechbyKile – a dummy variable of an innovative company. It is hardly surprising because Sector_dummy tests the extent of influence of companys pertaining to the medical industry, which is one of the sectors comprising innovative companies. Thus, it is not advisable to use these two variables simultaneously. Then the sample is divided into subsamples consisting of only innovative companies or non-innovative companies and regressions are applied.

Results

The results of pooled regression testing for innovative and non-innovative companies separately, as well as for the entire sample are presented in Table 8.

Table 8. Pooled regression by innovative and non-innovative companies separately and for the entire sample

Variable	full_pool_1	full_pool_h~h	full_pool_n~h
Hightechby~e	.04144263***	(omitted)	(omitted)
Sector_dummy	–.02932382***	–.02799415***	(omitted)
Country_du~y	–.00995699***	.01305893***	–.0178002***
GDP_growth	.00477623	–.01778377**	.00833596**
CashFlow	–.00001665	–.00001497	–.0000423
CF_volatil~1	–1.709e-06**	–2.242e-07	–6.493e-06***
Lev	3.467e-06	1.421e-06	6.321e-06
Ldebt	–.07701833***	–.07015211***	–.07481558***
FirmSize	.00449972***	.00333379***	.00530312***
DivPayout_~y	–.00812249***	–.00787106***	–.00723117***
RD	.24297057***	.17434378***	.24365596***
RD_dummy	.00055358	–.00586204***	.00221221***
Capex	–.06561927***	–.01867492***	–.17079205***

Variable	full_pool_1	full_pool_h~h	full_pool_n~h
Intangibles	–.10774234***	–.13430975***	–.09921924***
NLB_L2	.50198908***	.59055881***	.4629501***
WCR_L1	8.347e-07	–7.042e-08	.00001517
SGA	.0673171***	.06720242***	.06874516***
Springate_~e	.00004409***	–.00007644	.00005208***
CF_volatil~2	–5.650e-06***	–7.823e-07	–4.555e-06***
MtB_classic	–2.610e-08	4.255e-08	5.486e-06***
_cons	.18106508***	.22372653***	.178417***
N	108736	26171	82565
r2	.65581589	.73670743	.58323074
r2_a	.65575257	.73651613	.58313986

Standard errors: *** p <0.01; ** p <0.05; * p <0.1.

As a result, we have formed the following models.

The final model for the whole sample:

CASH ratio = 0.181 - 0.004FirmSize +
3.467eLev+0.242RD+0.0006RD_{dummy} +
+ 0.067SGA – 0.108Intangibles - 0.066Capex –
–1.709e$CF_{volatility1}$ – 5.65e$CF_{volatility2}$ –0.077LDebt +
+ 0.00004$Springate_{Score}$ + 0.502NLB +
+8.347eWCR+0.0047GDP_{growth} – 0.008$DivPayout_{dummy}$ +
+0.414High $_{tech\ dummy}$ – 0.0099$Country_{dummy}$ +
+0.0006RD_{dummy} – 0.0293$Sector_{dummy}$ + ε

The final model for the high-tech companies sample:

CASH ratio = 0.022 + 0.003FirmSize + 1.421eLev +
+ 0.174RD + 0.067SGA – 0.134Intangibles –
– 0.0186Capex – 2.242e$CF_{volatility1}$ – 7.823e$CF_{volatility2}$ –
– 0.070LDebt – 0.00007$Springate^{Score}$ + 0.590NLB –
– 7.042eWCR – 0.0177GDP_{growth} –
– 0.007DivPayout_dummy – 0.005D_dummy +
+ 0.0130$Country_{dummy}$-0.027$Sector_{dummy}$ +
+4.255e$MtB_{classic}$ + ε

The final model for the non-high-tech companies sample:

CASH ratio = 0.178 + 0.005FirmSize + 6.321eLev +
+ 0.243RD + 0 .068SGA – 0.099Intangibles –
– 0.170Capex -6.493e$CF_{volatility1}$ – 4.555e$CF_{volatility2}$ –
– 0.074LDebt + 0.00005Springate_Score + 0.462NLB +
+ 0.00001WCR + 0.008GDP_growth –
– 0.007DivPayout_dummy + 0.002RD_dummy –
– 0.017Country_dummy + ε

One may observe that in general all three model variations have a rather high explanatory power; at the same time, the dependence of the cash ratio on the selected variables of non-innovative companies is not as easily explained. The highest explanatory power is observed in the model built using the sample that consists of only innovative companies and amounts to 73% (R-squared = 0.73 for the sample of innovative companies, R-squared = 0.58 for non-innovative companies and R-squared = 0.65 for the entire sample).

On the basis of the results of the pooled model for the entire sample one may conclude that a company's affiliation with the high-tech industry is a significant factor in the market and that model testing using different subsamples is justified.

It should be noted that GDP growth rate, which was absolutely insignificant for the entire sample, turned out to be significant for both subsamples; moreover, its influence on the cash ratio indicator for each subsample was diametrically opposed. For innovative companies, GDP growth rate produces a negative influence on the cash ratio, notably at the significance level of 0.001, while for non-innovative companies, on the contrary, increase of GDP growth rate results in an increased cash ratio at the significance level of 0.01. This is probably due to the fact that in case of GDP growth macroclimate in countries improves, making it easier for companies to survive, which, in its turn, results in rising competition in the high-tech industry, where the most important thing is to survive and be the first to introduce their product in the market.

The Cashflow variable turned out to be insignificant in the model on the whole. In addition, the WCR variable was insignificant in all models, which is surprising because, for example, the priority of high-tech companies is operating, rather than financial, activities, however, the testing

results of the pooled model regression prove otherwise: the NLB_L1 variable is significant, while the WCR variable is insignificant. Changes in the cash flow from operations (CF_volatility1) also show a significance level of 0.01 in the model across the entire sample and for low-tech companies, but are absolutely insignificant for high-tech companies. At the same time, the relationship between this variable and the cash ratio is negative. It is rather logical because a company has no reason to save cash against the possibility of shocks when cash flows increase. It should be noted that the second version of cash flow volatility calculation – CF_volatility2 – shows approximately the same result, but this variable has a higher significance level when used in the model for the entire sample and in the sample of non-innovative companies in comparison to the first version.

Financial leverage had no influence on the cash ratio variable in any of the samples, however, the debt structure of a company turned out to be significant in all samples and has an inverse relationship with the cash ratio. When the long-term debt level is increased with respect to the level of the whole debt financing, the cash holdings level decreases, thus partially substantiating the theory on the influence of financial restrictions on the amount of corporate cash holdings.

In all samples the following variables turned out to be significant to various degrees and showed the same trend of influence on the cash ratio: company size (in the model of innovative companies this variable has a smaller coefficient than the same variable in the low-tech company model), dividend payout, R&D expenditures, capital expenditures; selling, general and administrative expenditures; size of intangible assets in relation to all company assets, NLB coefficient.

Bankruptcy probability is significant for the model of the entire sample and for the low-tech company sample; at the same time, a decrease of bankruptcy probability in these samples results in the growth of the cash ratio level. Presumably, it is due to the fact that a company with a high bankruptcy probability has no opportunity to save cash because it is spent on company's operations, while companies with a low probability of bankruptcy prefer to save cash.

Further we consider pooled models with breakdown of the sample into pharmaceutical/biotech and non-pharmaceutical companies and across the entire sample (Table 9).

Table 9. Pooled regression for pharmaceutical and non- pharmaceutical company samples and across the entire sample

Variable	full_pool_1	full_pool_h~h	full_pool_n~h
Hightechby~e	(omitted)	.04307556***	.04144263***
Sector_dummy	(omitted)	(omitted)	−.02932382***
Country_du~y	.00255824	−.0114674***	−.00995699***
GDP_growth	−.00375661	.00426147	.00477623
CashFlow	−.0000144	−.00002682	−.00001665
CF_volatil~1	−3.978e-06	−1.668e-06**	−1.709e-06**
Lev	.00129077***	3.156e-06	3.467e-06
Ldebt	−.06569355***	−.07711462***	−.07701833***
FirmSize	.00807605***	.00434588***	.00449972***
DivPayout_~y	−.0239487***	−.0063829***	−.00812249***
RD	.18512009***	.18558128***	.24297057***
RD_dummy	−.0080702***	.00199835***	.00055358
Capex	−.16328455***	−.06280315***	−.06561927***
Intangibles	−.16262382***	−.10445286***	−.10774234***
NLB_L2	.62818606***	.49116173***	.50198908***
WCR_L1	−7.062e-07	.00001543	8.347e-07
SGA	.04153918***	.07139322***	.0673171***
Springate_~e	−.0053206***	.00004743***	.00004409***

Variable	full_pool_1	full_pool_h~h	full_pool_n~h
CF_volatil~2	4.471e-06	−5.504e-06***	−5.650e-06***
MtB_classic	5.916e-08	−7.253e-09	−2.610e-08
_cons	.20129678***	.17952257***	.18106508***
N	6436	102300	108736
r2	.81601751	.64028818	.65581589
r2_a	.81550143	.64022135	.65575257

Standard errors: *** p <0.01; ** p <0.05; * p <0.1.

Regression analysis shows that when companies are divided into subsamples in a different way, the explanatory power of the model is enhanced.

Unlike for the model of all innovative companies, financial leverage is significant for pharmaceutical/biotech companies, while the dummy variable designating developed and emerging countries is insignificant. Similar to high-tech companies, medical/pharmaceutical companies demonstrate an extremely high globalization level, therefore it generally makes no difference for them in which country to operate. As for all other variables, the line of influence and degree of significance are similar to previous models when the sample is divided into high-tech/non-high-tech companies.

We also studied and tested three types of models to choose the most accurate and appropriate one.

Studied models:

- Fixed effect model – a regression in deviation of indicators from the time average for each object. This model eliminates the influence of time-invariant characteristics in order to evaluate the net influence of variables on the dependent variable. In this case, each company in the sample adds its individual effect to the global constant;
- Random effect model resembles the FE model, but forms the individual effect as an error instead of a constant. Time-invariant variables are preserved in this model;

Pooled model.

The choice between the pooled and FE models

When making a choice between the pooled and FE models, one should pay attention to F-statistics. In all versions of the FE model the zero hypothesis stating that the elements responsible for the individual effect are insignificant is rejected. Therefore, out of the pooled and FE models, we chose the fixed effect model.

The choice between the pooled and RE models, the Breusch-Pagan test

When making a choice between the pooled and RE models, it is necessary to perform the Breusch-Pagan test, which verifies the hypothesis stating that the dispersion of individual effects equals 0.

As a result, we rejected the zero hypothesis and chose the RE model (Table 10).

Table 10. A complete RE model

Variable	Coef.	Z	P>z	Std. Err.
HightechbyKile	.0514289	32.21	0.000	.0015968
Sector_dummy	−.0244458	−8.62	0.000	.002835
Country_dummy	−.0052547	−4.06	0.000	.0012947
GDP_growth	−.0022927	−1.32	0.187	.0017393
CashFlow	−8.67e-06	−1.61	0.107	5.38e-06
CF_volatility_1	−1.63e-07	−0.41	0.683	3.99e-07
Lev	1.05e-06	0.73	0.465	1.44e-06
Ldebt	−.0469826	−76.62	0.000	.0006132

Variable	Coef.	Z	P>z	Std. Err.
FirmSize	.0030324	10.53	0.000	.0002881
DivPayout_dummy	–.0044481	–9.27	0.000	.00048
RD	.0362406	4.20	0.000	.008623
RD_dummy	–.0024362	–4.12	0.000	.000592
Capex	–.0275021	–14.85	0.000	.0018517
Intangibles	–.1772302	–49.88	0.000	.0035529
NLB_L2	.4922331	384.27	0.000	.001281
WCR_L1	2.12e-06	1.97	0.049	1.08e-06
SGA	.0303175	14.06	0.000	.0021561
Springate_score	.0000388	5.16	0.000	7.52e-06
CF_volatility_2	–7.15e-06	–5.52	0.000	1.29e-06
MtB_classic	1.16e-07	2.73	0.006	4.27e-08
_cons	.1827534	102.27	0.000	.001787
sigma_u	.06346205			
sigma_e	.04615585			
Rho	.65403801			

Standard errors: *** p <0,01, ** p <0,05, * p <0,1.

The Haussman Test

Now we need to choose between the FE and RE models. For this purpose, we conduct the Haussman test where the zero hypothesis states that the RE model is preferable to the alternative FE model. Mainly we verify whether unique errors are related to regressors. The zero hypothesis states that there is no relationship.

The Wald Test

The next stage is the testing of the selected FE model for heteroscedasticity. For this purpose, we verify the model by applying the modified Wald test. The testing results show that if there is heteroscedasticity in the model, robust standard errors are introduced to mitigate the heteroscedasticity effect.

You can see the result of testing the FE model with robust standard errors across the whole sample, in innovative companies and other companies in the sample (Table 11).

Table 11. FE model using robust standard errors across the entire sample of companies as well as in high-tech and non-high-tech companies

Variable	fe_non_high~t	fe_high_tec~t	fe_full_rob~t
Hightechby~e	(omitted)	(omitted)	(omitted)
Sector_dummy	(omitted)	(omitted)	(omitted)
Country_du~y	(omitted)	(omitted)	(omitted)
GDP_growth	.00017332	–.01304373**	–.00353664
CashFlow	–.00003203	–5.771e-06**	–8.209e-06*
CF_volatil~1	1.154e-06*	–2.194e-07	–1.981e-08

Variable	fe_non_high~t	fe_high_tec~t	fe_full_rob~t
Lev	−1.106e-06	2.145e-06***	9.766e-07
Ldebt	−.03823258***	−.05475872***	−.04334387***
FirmSize	.00184989	.00598256**	.00303322*
DivPayout_~y	−.00215961*	−.00512545***	−.00338009***
RD	−.0606296	.00324509	−.01462614
RD_dummy	−.00417975***	−.00181952	−.00330704**
Capex	−.10304346***	−.00380872	−.02418796
Intangibles	−.1831463***	−.19934908***	−.20036695***
NLB_L2	.45238543***	.56511748***	.48698371***
WCR_L1	.00002897***	1.247e-06***	2.224e-06**
SGA	.01886729*	.0110307	.00866056
Springate_~e	.00004585***	−.00001662	.00003912***
CF_volatil~2	(omitted)	(omitted)	(omitted)
MtB_classic	6.453e-07	1.424e-07***	1.331e-07***
N	82565	26171	108736
r2	.54267519	.69033815	.58829088
r2_a	.54258655	.69014871	.58823029
F	508.97997	1310.2036	376.37002

Standard errors: *** p <0.01; ** p <0.05; * p <0.1.

Analysis of Results

Company size

Company size is important for the complete sample and a sample comprised of only innovative companies. Thus, for the whole sample the size is significant at a 0.05 level, and for innovative companies – at a 0.01 level. The coefficient for innovative companies is also greater than for the whole sample, which is indicative of a greater impact on the cash ratio when this parameter is changed to 1. For non-innovative companies the size was insignificant.

In general, in all three samples company size is related positively to cash ratio: the bigger a company, the larger its cash holdings. Thus, hypothesis *H3* is partially validated. The FirmSize variable in this paper does not confirm the transactional motive of accumulating cash holdings, unlike in the paper by Drobetz et al. [52]. Moreover, in the model with only innovative companies the extent of influence of company size on cash holdings turned out to be the highest among the three samples. This also rejects the presence of the transactional motive of innovative companies proposed in the paper by Ozkan et al [54].

However, according to theory, a positive influence of company size is a sign of existence of the agency motive, but since for all companies the debt level is apparently significant and its relationship to the cash ratio is negative, one may presume, as does the research by Lee et al. [29], that during a crisis and postcrisis companies of any size face financial restrictions.

Liquidity Coefficients

The two variables WCR and NLB are used to evaluate liquidity. In all three regressions these indicators turned out to be significant and had a positive influence on the cash ratio, which contradicts the results of Ferreira et al. [57] and Opler et al. [56]. At the same time, the strongest influence of NLB is observed in high-tech companies (the variable coefficient is 0.565), which is unexpected because high-tech companies place greater focus on operations management instead of financial management.

Thus, hypothesis *H1* proposed at the beginning was rejected as a result of this research and the transactional motive was not confirmed.

Company's Growth Opportunities

In view of the incomplete data on the MtB_classic indicator, we cannot be sure that the result obtained for the whole sample and non-innovative companies is absolutely dependable, although for some non-high-tech companies the data was obtained due to a difference in classification of innovative companies in the BICS classifier and the sample of SIC code.

The results show that this proxy variable is significant in the model for companies from the entire sample, particularly for high-tech companies; at the same time, the model coefficient for high-tech companies is higher, which is not surprising. The obtained result of the positive influence of this variable on the innovative companies' cash holding level is aligned with the results of other researchers [1; 42; 58; 60; 61; 72].

Financial Leverage

The financial leverage variable turned out to be insignificant for all samples except for innovative companies, where influence of the leverage has a positive impact on cash holdings.

Debt Repayment Structure

All three samples demonstrate a negative relationship between the amount of the long-term debt and cash ratio, especially for innovative companies: in this model the coefficient is the biggest in modulus, which indicates that cash is probably used to repay corporate debt.

The research produced two exactly opposite effects for debt-related variables. On the one hand, the financial leverage variable has a positive impact on the cash ratio of innovative companies, however, at the same time the debt structure variable shows that cash holdings of any company that prefers long-term debt financing should decrease. This indicates that there is most probably an effect of preference of short-term debt operations financing in financial leverage. A similar observation was mentioned in paper by Bates et al. [1]. This presumption may explain the difference in the line of influence of the Ldebt and Lev variables on cash holdings.

Cash Flow Volatility

Fundamentally, this variable turned out to be insignificant in the first version of model calculation for the whole sample and for innovative companies; however, in low-tech companies this variable has a slight positive influence on cash holdings. The second variation of volatility may be assessed only by applying the RE model. In the RE model the second variable has an obvious negative relationship with the cash ratio. However, in spite of the fact that in the whole sample and in non-innovative companies CF_volatility2 turned out to be significant, cash flow volatility produces no significant influence on cash holdings for innovative companies. The coefficient of the model for high-tech companies only is significantly lower than of other models.

Generally, we may consider hypothesis H*4* rejected because this variable has no significance in the explanation of cash holdings of innovative companies and its influence is the exact opposite of the researchers' expectations.

R&D Expenditures

One of the most significant variables – R&D – turned out to be completely insignificant for the FE model as a whole. At the same time, the influence of this variable on cash ratio is negative, which contradicts hypothesis *H3* about a positive influence of RD on cash holdings. Thus, we tested variations of the model for RD and RD_dummy variables separately (Table 12 and 13). The results of these models showed that both RD and RD_dummy have a negative effect on cash holdings, but if the RD variable is still insignificant in all models, RD_dummy is significant for the sample as a whole and for low-tech companies. At the same time. in the latter sample the influence is greater than in the whole sample, which indicates that neither size nor the fact of incurring R&D expenditures are of any importance for innovative companies. Therefore, this confirms the result of the research performed by PWC [18] (concerning the amount of R&D expenditures).

Table 12. The FE model using robust standard errors for the whole sample of companies, as well as high-tech and non-high-tech companies without the RD_dummy variable

Variable	fe_non_high~h	fe_high_tech	fe_full_rob~t
Hightechby~e	(omitted)	(omitted)	(omitted)
Sector_dummy	(omitted)	(omitted)	(omitted)
Country_du~y	(omitted)	(omitted)	(omitted)
GDP_growth	.00084592	−.01251645**	−.00287144
CashFlow	−.00003178	−5.670e-06**	−8.024e-06
CF_volatil~1	1.176e-06*	−2.257e-07	−2.583e-08
Lev	−1.109e-06	2.158e-06***	9.918e-07

Variable	fe_non_high~h	fe_high_tech	fe_full_rob~t
Ldebt	−.0381406***	−.05474813***	−.04327181***
FirmSize	.00137565	.00567137**	.00258814*
DivPayout_~y	−.00262077**	−.00524879***	−.0037344***
RD	−.09593725	−.00058857	−.02518635
Capex	−.10201718***	−.00378516	−.02398725
Intangibles	−.18609835***	−.20040651***	−.20273037***
NLB_L2	.45242554***	.56517477***	.48701988***
WCR_L1	.00002925***	1.268e-06***	2.264e-06**
SGA	.01880381*	.01089707	.00847615
Springate_~e	.00004582***	−.00001689	.00003908***
CF_volatil~2	(omitted)	(omitted)	(omitted)
MtB_classic	6.760e-07	1.426e-07***	1.335e-07***
_cons	.18708942***	.21904228***	.195776***
N	82565	26171	108736
r2	.54247892	.69031169	.58817732
r2_a	.54239578	.69013408	.5881205
F	540.18016	1390.9392	395.40301

Standard errors: *** p <0.01; ** p <0.05; * p <0,1.

Table 13. The FE model using robust standard errors for the whole sample of companies, as well as high-tech and non-high-tech companies using only the RD_dummy variable

Variable	fe_non_high~h	fe_high_tech	fe_full_rob~t
Hightechby~e	(omitted)	(omitted)	(omitted)
Sector_dummy	(omitted)	(omitted)	(omitted)
Country_du~y	(omitted)	(omitted)	(omitted)
GDP_growth	.00024113	−.01303873**	−.00353174
CashFlow	−.00003202	−5.765e-06**	−8.212e-06*
CF_volatil~1	1.146e-06*	−2.199e-07	−1.876e-08
Lev	−1.105e-06	2.145e-06***	9.774e-07
Ldebt	−.0382285***	−.05475874***	−.04334457***
FirmSize	.00183039	.00596617**	.0030452*
DivPayout_~y	−.00221024*	−.00512125***	−.00339038***
RD_dummy	−.00477607***	−.00172924	−.00352567***

Variable	fe_non_high~h	fe_high_tech	fe_full_rob~t
Capex	−.10295384***	−.00381647	−.02416101
Intangibles	−.18325664***	−.19942601***	−.20023638***
NLB_L2	.4523531***	.5651113***	.48699214***
WCR_L1	.00002891***	1.249e-06***	2.221e-06**
SGA	.0175477*	.01128292	.00792359
Springate_~e	.00004589***	−.00001731	.00003915***
CF_volatil~2	(omitted)	(omitted)	(omitted)
MtB_classic	6.358e-07	1.425e-07***	1.329e-07***
_cons	.18570769***	.21849974***	.19434517***
N	82565	26171	108736
r2	.5426271	.69033704	.58828048
r2_a	.54254399	.69015945	.58822368
F	542.4207	1380.2093	400.56672

Standard errors: *** p <0.01; ** p <0.05; * p <0,1.

Capex

Capital expenditures have a negative relationship with cash holdings, however, at the same time this variable is significant only for low-tech companies.

Intangible assets

They have a significant negative influence on cash ratio in all subsamples, at the same time this variable has the most influence when used for the whole sample. The value for innovative companies is a little less than for the first sample. The negative relationship between cash ratio and intangibles may be due to the fact that it is easier/economically more advantageous for the company to purchase intangible assets for cash.

Dividend Payout

It has a predictably negative influence on cash ratio as was stated in the paper by Bates et al. [1]; at the same time this influence is greater for innovative companies, which may be indicative of the agency motive. Dividend payments are also a message for external investors that a company needs cash to protect itself from shocks to a lesser extent.

Probability of Bankruptcy

An increased Springate Z-score, i.e. a decreased probability of bankruptcy in the entire sample and in the sample of only non-innovative companies results in cash ratio growth, thus disconfirming the preventive motive. However, in spite of the absence of significance in the model of this variable for innovative companies, its negative relationship with the cash ratio should be noted.

GDP growth rate

It is of no significance for the whole sample and for its largest component – low-tech companies. However, the model with innovative companies shows a particularly significant negative relationship between the cash ratio and GDP growth rate. This, on the one hand, confirms the first part of hypothesis H2, which states that when GDP grows, the amount of cash holdings decreases, but disproves its second part. Here is a summary of results of hypotheses testing:

- H1: rejected.
- H2: confirmed partially.
- H3: confirmed partially.
- H4: rejected.

Conclusion

In this paper we examine the determinants of corporate cash holdings, including innovative companies in 2009–2014. We confirmed the existence of the phenomenon of innovative companies' large cash holdings. At the same time, however, there was no particularly significant growth of cash ratio in the period analyzed in this paper. An attempt to study cash ratio exclusively in terms of theoretically defined motives proved to be unsustainable because in the modern world, provided a viable company operates efficiently, there are other motives for accumulating cash. It is confirmed by the fact that no theory was vindicated completely or rejected by all proxy variables.

The validity of adding of a macroeconomic factor variable (GDP growth) to the research model for innovative

companies was demonstrated. In spite of an insignificant influence of GDP on the sample as a whole, for innovative companies an increased GDP growth rate results in a decreased cash ratio.

The revealed insignificance of R&D expenditures for innovative companies is in line with the conclusions of modern information and consulting agencies. Thus, the inexpediency of ranking companies by the amount of R&D expenditures and the use of this variable as proxy innovation is proven. Predictably, a positive relationship between growth opportunities, company size and cash ratio, as well as a negative relationship between dividend payments and the amount of cash holdings was confirmed.

It follows herefrom that an understanding of the reasons for cash accumulation may facilitate prudential management of cash holdings in companies.

References

1. Bates T.W., Kahle K.M., Stulz R.M. Why do US firms hold so much more cash than they used to? *The Journal of Finance*. 2009;64(5):1985-2021. https://doi.org/10.1111/j.1540-6261.2009.01492.x
2. Sánchez J.M., Yurdagul E. Why are corporations holding so much cash? *The Regional Economist*. 2013;21(1):5-8. URL: https://www.stlouisfed.org/publications/regional-economist/january-2013/why-are-corporations-holding-so-much-cash
3. Daher M. The determinants of cash holdings in UK public and private firms. Doctoral dissertation. Lancaster: Lancaster University; 2010.
4. Manzi J., Tesher D., Wilson G., Grimando L., Wong A., Khan F. U.S. corporate cash reaches $1.9 trillion but rising debt and tax reform pose risk. S&P Global. May 25, 2017. URL: https://www.spglobal.com/en/research-insights/articles/us-corporate-cash-reaches-19-trillion-but-rising-debt-and-tax-reform-pose-risk
5. Obiols M. The world's richest companies 2018: Global finance cash 25. Global Finance. Sept. 01, 2018. URL: https://www.gfmag.com/magazine/september-2018/global-finance-cash-25-2018
6. Pinkowitz L., Stulz R.M., Williamson R. Multinationals and the high cash holdings puzzle. NBER Working Paper. 2012;(18120). URL: https://www.nber.org/system/files/working_papers/w18120/w18120.pdf
7. Lyandres E., Palazzo B. Cash holdings, competition, and innovation. *Journal of Financial and Quantitative Analysis*. 2016;51(6):1823-1861. https://doi.org/10.1017/S0022109016000697
8. Graham J.R., Leary M.T. The evolution of corporate cash. *The Review of Financial Studies*. 2018;31(11):4288-4344. https://doi.org/10.1093/rfs/hhy075
9. Booth L., Zhou J. Increase in cash holdings: Pervasive or sector-specific? *Frontiers in Finance and Economics*. 2013;10(2):31-62.
10. Myers S.C., Majluf N.S. Corporate financing and investment decisions when firms have information that investors do not have. *Journal of Financial Economics*. 1984;13(2):187-221. https://doi.org/10.1016/0304-405X(84)90023-0
11. Barefoot K., Curtis D., Jolliff W., Nicholson J.R., Omohundro R. Defining and measuring the digital economy. Bureau of Economic Analysis Working Paper. 2018;(15). URL: https://www.bea.gov/sites/default/files/papers/defining-and-measuring-the-digital-economy.pdf
12. Oslo manual: Guidelines for collecting and interpreting innovation data. Paris: OECD/European Communities; 2005. 164 p. (Russ. ed.: Rukovodstvo Oslo. Rekomendatsii po sboru i analizu dannykh po innovatsiyam. Moscow: Centre for Science Research and Statistics; 2010. 107 p.).
13. Brown J.R., Petersen B.C. Cash holdings and R&D smoothing. *Journal of Corporate Finance*. 2011;17(3):694-709. https://doi.org/10.1016/j.jcorpfin.2010.01.003
14. Parthasarthy R., Hammond J. Product innovation input and outcome: Moderating effects of the innovation process. *Journal of Engineering and Technology Management*. 2002;19(1):75-91. https://doi.org/10.1016/S0923-4748(01)00047-9
15. He Z., Wintoki M.B. The cost of innovation: R&D and high cash holdings in U.S. firms. *Journal of Corporate Finance*. 2016;41:280-303. https://doi.org/10.1016/j.jcorpfin.2016.10.006
16. Kivimäki M., Lansisalmi H., Elovainio M., Heikkila A., Lindstrom K., Harisalo R., Sipila K., Puolimatka L. Communication as a determinant of organizational innovation. *R&D Management*. 2000;30(1):33-42. https://doi.org/10.1111/1467-9310.00155
17. Begenau J., Palazzo B. Firm selection and corporate cash holdings. *Journal of Financial Economics*. 2021;139(3):697-718. https://doi.org/10.1016/j.jfineco.2020.09.001
18. Jaruzelski B., Chwalik R., Goehle B. What the top innovators get right. PwC. 2018. URL: https://www.strategy-business.com/feature/What-the-Top-Innovators-Get-Right?gko=e7cf9
19. Ringel M., Zablit H. The most innovative companies 2018. BCG. Jan. 17, 2018. URL: https://www.bcg.com/ru-ru/publications/2018/most-innovative-companies-2018-innovation.aspx
20. Ercis A., Unalan M. Analysis of the world's most innovative companies on the basic of industry: 2005-2014. *Procedia – Social and Behavioral Sciences*.

2015;195:1081-1086. https://doi.org/10.1016/j.sbspro.2015.06.152

21. The 2018 global innovation 1000 study. PwC. 2019. URL: https://www.strategyand.pwc.com/innovation1000

22. The world's most innovative companies. Forbes. 2018. URL: https://www.forbes.com/innovative-companies/list/#tab:rank

23. Aghion P., Tirole J. The management of innovation. *The Quarterly Journal of Economics*. 1994;109(4):1185-1209. https://doi.org/10.2307/2118360

24. Scherer F.M. Inter-industry technology flows and productivity growth. *The Review of Economics and Statistics*. 1982;64(4):627-634. https://doi.org/10.2307/1923947

25. Schmookler J. Invention and economic growth. Cambridge, MA: Harvard University Press; 1966. 332 p.

26. Trajtenberg M. A penny for your quotes: Patent citations and the value of innovations. *The Rand Journal of Economics*. 1990;21(1):172-187. https://doi.org/10.2307/2555502

27. Hall B.H., Jaffe A., Trajtenberg M. Market value and patent citations. *The RAND Journal of Economics*. 2005;36(1):16-38. URL: https://eml.berkeley.edu//~bhhall/papers/HallJaffeTrajtenberg_RJEjan04.pdf

28. Argyres N.S., Silverman B.S. R&D, organization structure, and the development of corporate technological knowledge. *Strategic Management Journal*. 2004;25(8-9):929-958. https://doi.org/10.1002/smj.387

29. Lee Y.-G., Lee J.-D., Song Y.-I., Lee S.-J. An in-depth empirical analysis of patent citation counts using zero-inflated count data model: The case of KIST. *Scientometrics*. 2007;70(1):27-39. https://doi.org/10.1007/s11192-007-0102-z

30. Hirschey M., Richardson V.J. Are scientific indicators of patent quality useful to investors? *Journal of Empirical Finance*. 2004;11(1):91-107. https://doi.org/10.1016/j.jempfin.2003.01.001

31. Schroth E., Szalay D. Innovation races and the strategic role of cash holdings: Evidence from pharmaceutical patents. University of Warwick Working Paper. 2007. URL: https://www.econ1.uni-bonn.de/pdf-files/innovation-races

32. Iskandar-Datta M.E., Jia Y. Cross-country analysis of secular cash trends. *Journal of Banking & Finance*. 2012;36(3):898-912. https://doi.org/10.1016/j.jbankfin.2011.10.003

33. Qiu J., Wan C. Technology spillovers and corporate cash holdings. *Journal of Financial Economics*. 2015;115(3):558-573. https://doi.org/10.1016/j.jfineco.2014.10.005

34. Zhou J. Increase in cash holdings: Pervasive or sector-specific? University of Toronto Working Paper. 2009. URL: https://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.716.8339&rep=rep1&type=pdf

35. Castro P., Tascón M.T., Amor-Tapia B. Dynamic analysis of capital structure in technological firms based on their life cycle stages. *Spanish Journal of Finance and Accounting/Revista Española de Financiación y Contabilidad*. 2015;44(4):458-486. https://doi.org/10.1080/02102412.2015.1088202

36. Loughran T., Ritter J. Why has IPO underpricing changed over time? *Financial Management*. 2004;33(3):5-37. URL: https://site.warrington.ufl.edu/ritter/files/2015/06/Why-Has-IPO-Underpricing-Changed-Over-Time-2004.pdf

37. Trejo-Pech C.O., Gunderson M.A., Baker T.G., Gray A.W., Boehlje M.D. Assessing cash holdings in agribusiness. *International Food and Agribusiness Management Review*. 2015;18(4):85-104. https://doi.org/10.22004/ag.econ.211655

38. Ariff A.M. Governance and voluntary disclosure of intangibles. *Corporate Ownership & Control*. 2013;11(1-6):600-610.

39. Kokoreva M., Stepanova A., Povkh K. Could high-tech companies learn from others while choosing capital structure? *SSRN Electronic Journal*. 2017. http://dx.doi.org/10.2139/ssrn.3060316

40. Kile C.O., Phillips M.E. Using industry classification codes to sample high-technology firms: Analysis and recommendations. *Journal of Accounting, Auditing & Finance*. 2009;2 (1):35-58. https://doi.org/10.1177/0148558X0902400104

41. Baldwin J.R., Gellatly G. Are there high-tech industries or only high-tech firms? Evidence from new technology-based firms. *SSRN Electronic Journal*. 1999. https://doi.org/10.2139/ssrn.143867

42. Foley C.F., Hartzell J.C., Titman S., Twite G. Why do firms hold so much cash? A tax-based explanation. *Journal of Financial Economics*. 2007;86(3):579-607. https://doi.org/10.1016/j.jfineco.2006.11.006

43. Himmelberg C.P., Petersen B.C. R&D and internal finance: A panel study of small firms in high-tech industries. *The Review of Economics and Statistics*. 1994;76(1):38-51. https://doi.org/10.2307/2109824

44. Guiso L. High-tech firms and credit rationing. *Journal of Economic Behavior & Organization*. 1998;35(1):39-59. https://doi.org/10.1016/S0167-2681(97)00101-7

45. Carpenter R.E., Petersen B.C. Capital market imperfections, high-tech investment,

and new equity financing. *The Economic Journal*. 2002;112(477):F54-F72. https://doi.org/10.1111/1468-0297.00683

46. Myers S.C. The capital structure puzzle. *The Journal of Finance*. 1984;39(3):574-592. https://doi.org/10.1111/j.1540-6261.1984.tb03646.x

47. Rampini A.A., Viswanathan S. Collateral, risk management, and the distribution of debt capacity. *The Journal of Finance*. 2010 65(6):2293-2322. https://doi.org/10.1111/j.1540-6261.2010.01616.x

48. Chen H.-L., Hsu W.-T., Huang Y.-S. Top management team characteristics, R&D investment and capital structure in the IT industry. *Small Business Economics*. 2010;35(3):319-333. https://doi.org/10.1007/s11187-008-9166-2

49. Keynes J.M. The general theory of employment interest and money. London: Macmillan; 1936. 403 p.

50. Baumol W.J. The transactions demand for cash: An inventory theoretic approach. *The Quarterly Journal of Economics*. 1952;66(4):545-556. https://doi.org/10.2307/1882104

51. Miller M.H., Orr D. A model of the demand for money by firms. *The Quarterly Journal of Economics*. 1966;80(3):413-435. https://doi.org/10.2307/1880728

52. Drobetz W., Grüninger M.C. Corporate cash holdings: Evidence from Switzerland. *Financial Markets and Portfolio Management*. 2007;21(3):293-324. https://doi.org/10.1007/s11408-007-0052-8

53. Mulligan C.B. Scale economies, the value of time and the demand for money: Longitudinal evidence from firms. *Journal of Political Economy*. 1997;105(5):1061-1079. https://doi.org/10.1086/262105

54. Ozkan A., Ozkan N. Corporate cash holdings: An empirical investigation of U.K. companies. *Journal of Banking & Finance*. 2004;28(9):2103-2134. https://doi.org/10.1016/j.jbankfin.2003.08.003

55. Shulman J.M., Cox R.A.K. An integrative approach to working capital management. *Journal of Cash Management*. 1985;5(6):64-67. URL: https://www.researchgate.net/publication/235955087_An_Integrative_Approach_to_Working_Capital_Management

56. Opler T., Pinkowitz L., Stulz R., Williamson R. The determinants and implications of corporate cash holdings. *Journal of Financial Economics*. 1999;52(1):3-46. https://doi.org/10.1016/S0304-405X(99)00003-3

57. Ferreira M.A., Vilela A.S. Why do firms hold cash? Evidence from EMU countries. *European Financial Management*. 2004;10(2):295-319. https://doi.org/10.1111/j.1354-7798.2004.00251.x

58. Harford J., Mansi S.A., Maxwell W.F. Corporate governance and firm cash holdings in the US. *Journal of Financial Economics*. 2008;87(3):535-555. https://doi.org/10.1016/j.jfineco.2007.04.002

59. García-Teruel P.J., Martínez-Solano P. On the determinants of SME cash holdings: Evidence from Spain. *Journal of Business Finance & Accounting*. 2008;35(1-2):127-149. https://doi.org/10.1111/j.1468-5957.2007.02022.x

60. Kim C.-S., Mauer D.C., Sherman A.E. The determinants of corporate liquidity: Theory and evidence. *Journal of Financial and Quantitative Analysis*. 1998;33(3):335-359. https://doi.org/10.2307/2331099

61. Almeida H., Campello M., Weisbach M.S. The cash flow sensitivity of cash. *The Journal of Finance*. 2004;59(4):1777-1804. https://doi.org/10.1111/j.1540-6261.2004.00679.x

62. Han S., Qiu J. Corporate precautionary cash holdings. *Journal of Corporate Finance*. 2007;13(1):43-57. https://doi.org/10.1016/j.jcorpfin.2006.05.002

63. Fever rising There are reasons to hope that the latest biotech boom will not be followed by another bust. The Economist. Feb. 15, 2014. URL: http://www.economist.com/news/business/21596557-there-are-reasons-hope-latest-biotech-boom-will-not-be-followed-another

64. Schroth E., Szalay D. Cash breeds success: The role of financing constraints in patent races. *Review of Finance*. 2010;14(1):73-118. https://doi.org/10.1093/rof/rfp020

65. Sinarti, Sembiring T.M. Bankruptcy prediction analysis of manufacturing companies listed in Indonesia Stock Exchange. *International Journal of Economics and Financial Issues*. 2015;5(1S):354-359. URL: https://www.econjournals.com/index.php/ijefi/article/view/1475/pdf

66. Boritz J.E., Kennedy D.B., Sun J.Y. Predicting business failure in Canada. *Accounting Perspectives*. 2007;6(2):141-165. https://doi.org/10.1506/G8T2-K05V-1850-52U4

67. Jensen M.C. Agency costs of free cash flow, corporate finance and takeovers. *The American Economic Review*. 1986;76(2):323-329.

68. Dittmar A., Mahrt-Smith J., Servaes H. International corporate governance and corporate cash holdings. *Journal of Financial and Quantitative Analysis*. 2003;38(1):111-133. https://doi.org/10.2307/4126766

69. Pinkowitz L., Stulz R., Williamson R. Does the contribution of corporate cash holdings and dividends to firm value depend on governance? A cross-country analysis. *The Journal of Finance*.

2006;61(6):2725-2751. https://doi.org/10.1111/j.1540-6261.2006.01003.x

70. Faulkender M., Petersen M. Investment and capital constraints: Repatriations under the American jobs creation act. *The Review of Financial Studies*. 2012;25(11):3351-3388. https://doi.org/10.1093/rfs/hhs092

71. Azar J.A., Kagy J.-F., Schmalz M.C. Can changes in the cost of carry explain the dynamics of corporate "cash" holdings? *The Review of Financial Studies*. 2016;29(8):2194-2240. https://doi.org/10.1093/rfs/hhw021

72. Barasa C., Achoki G., Njuguna A. Determinants of corporate cash holding of non-financial firms listed on the Nairobi Securities Exchange. *International Journal of Business and Management*. 2018;13(9):222. https://doi.org/10.5539/ijbm.v13n9p222

The article **was submitted** 16.01.2022; **approved after reviewing** 16.02.2022; **accepted for publication** 24.02.2022.

DOI: https://doi.org/10.17323/j.jcfr.2073-0438.16.1.2022.136-145
JEL classification: G30, G40, G41

CEO Power and Risk-taking: Intermediate Role of Personality Traits

Denis Korablev ✉
Research Intern Corporate Finance Center, School of Finance, National Research University Higher School of Economics, Moscow, Russia, korablevdwork@gmail.com, ORCID

Dmitry Podukhovich
Research Intern Corporate Finance Center, School of Finance, National Research University Higher School of Economics, Moscow, Russia, dpoduhovich@hse.ru, ORCID

Abstract

The authors examine the ways in which different personal characteristics of a CEO under the influence of CEO power may in turn affect personal risk-taking. Agency theory states that managers have non-changing risk preferences and are either risk-averse or risk-neutral. However, there may be cases when managers are risk-seekers, and the power of executives is positively related to excessive risk-taking. Additionally, agency theory assumes that CEOs are homogenous in power use and ignores the difference between CEOs in terms of personality traits, as well as their impact on corporate decisions. Therefore, our aim is to focus specifically on the factors that connect CEO power to CEO risk-taking and to analyze the possible effects of this relationship on a firm. Based on both psychological and managerial studies, we conclude that, on the one hand, a CEO's power can affect their personal traits by producing [in the case of overconfidence or hubris] or enhancing them [in case of narcissism]. On the other hand, CEOs' personal traits affect their risk-taking. It can occur either through changing risk perception or due to behavior patterns inherent in those traits. Finally, we hypothesize that CEO power can affect CEO personal risk-taking through personality traits. By examining the relationship between CEO power and CEO risk-taking based on individual-level determinants, our paper adds to the behavioral corporate finance and corporate governance literature.

Keywords: CEO power, CEO personality traits, CEO risk-taking, corporate governance, behavioral finance

For citation: Korablev, D., and Podukhovich, D. CEO Power and Risk-taking: Intermediate Role of Personality Traits. *Journal of Corporate Finance Research.* 2022;16(1): 136-145. https://doi.org/10.17323/j.jcfr.2073-0438.16.1.2022.136-145

Introduction

Agency theory, driven by the idea of divergent interests of the parties who own and control the firm, stipulates that company managers are more risk-averse than shareholders want them to be [1–3]. That is why the issue of corporate governance is to establish proper mechanisms that would amend managers' orientation in terms of their risk-taking preferences [4]. Despite a substantial amount of research devoted to the association between managerial risk-taking and corporate governance mechanisms, the results are still imprecise [5]. The problem may lie in the acceptance of the agency theory, which states that managers have non-changing risk preferences and are either risk-averse or risk-neutral [4; 6; 7]. Conversely, there may be cases when managers are risk-seekers, and the power of executives is positively related to excessive risk-taking. This additional assumption was proposed by social psychology scholars apart from the classical agency perspective [8]. The most important point here is that if managerial interests are in line with the shareholders' interests, corporate risk-taking will yield benefits. However, if there is a misalignment of managerial beliefs with shareholders' attitudes, additional risk may be harmful for the firm [9].

Unfortunately, agency theory largely ignores the possibility that agency problems may vary at the personal level. However, academic literature is currently shifting its focus from exploration of company-level determinants of corporate risk-taking to individual-level determinants. The vast body of contemporary research attempts to investigate how psychological and demographic characteristics of top managers influence corporate risk-taking attitudes [10]. For example, innate attributes of executives, such as overconfidence [11], narcissism [12], hubris [13], sensation seeking [14], education [15], military background [16], early life experiences [17], religious belief [18], and political affiliations are of interest [19]. Moreover, the fraction of variance in firm performance explained by CEOs' individual characteristics has grown substantially over the last decades [20].

Agency theory also ignores the impact of CEO power on individual-level processes. Alternatively, a bulk of recent research in the field of social psychology has substantiated that on the individual level power has the ability to alter basic psychological processes [21]. It was reasonable to look at power through the lens of two neurobiological systems, namely, inhibition and approach systems, to explain the differences in individuals' behavior [22]. Research demonstrated that the activation of each system leads to differences in individuals' attitude to risk preferences [8; 23]. Accordingly, in our paper we hypothesize that a CEO's personal characteristics may be affected by a CEO's power, which in turn affects their personal risk-taking attitude.

In our study we explore the link between CEO power, personal traits and risk-taking on the individual level. There is abundant evidence in both theory and practice that CEO has the most influential role within the company and is the driver of company decisions and outcomes [24–26]. Moreover, we postulate that different authority levels of CEOs' positions may lead to different attitudes to risks. Therefore, the aim of this paper is to focus specifically on the factors that connect CEO power with CEO risk-taking and to analyze the possible effects of this relationship on firm performance.

Based on existing studies, we propose that CEO power may be one of the factors affecting CEO risk-taking. On the one hand, CEO power can affect their personal traits, producing or enhancing them. Based on psychological studies, we can conclude that power can act both as the underlying condition for traits to emerge or develop [in the case of overconfidence or hubris] and as an enhancement factor [in case of narcissism]. On the other hand, CEOs' personal traits affect their risk-taking either by changing their perception of risk, or because of behavior patterns inherent in those traits. This relationship expands the existing theories that connect CEOs' power and risk-taking, including corporate risk-taking. By examining the relationship between CEO power and CEO risk-taking based on individual-level determinants, our paper adds to the literature on behavioral corporate finance and corporate governance. As far as we are aware, our study is the first attempt to link CEO power and personal risk-taking based on personality traits.

The paper is structured in following way: we begin with an analysis of the relationship between CEO power and personality traits, then we proceed to examining the risk-taking patterns with respect to personality traits, finally, we combine the two parts in order to connect CEO power and risk-taking behavior.

CEO power and personality traits

CEO power has one of the key roles in the relationship between CEO and shareholders. Agency theory postulates that since shareholders are widely dispersed, it is hard for them to effectively monitor and control CEO behavior. Lack of control leads powerful CEO to use this power to engage in self-serving actions at the expense of company owners. Thus, we can expect that the presence of a powerful CEO may impact corporate performance. Indeed, a significant amount of research provide interesting insights into this relationship. For instance, empirical findings suggest that CEO power is associated with the firm's financial performance, performance volatility and productivity [27–33], IPO, M&A and divestitures [34–36]; innovativeness [37; 38]; dividend policy [39; 40], firm performance under turbulent conditions [41; 42] and most importantly for our study of the company's risk attitude [43–49].

Despite extensive literature coverage, the topic of CEO power remains open for discussion. Indeed, existing studies do provide an understanding of how CEO power can affect corporate performance. However, they still fail to provide conventional wisdom on this relationship, as results often lead to contradictory conclusions. One of the likely shortcomings of agency theory is that CEOs are viewed to be homogeneous in their use of power. Seeing CEOs as agents who are expected to behave in a certain way based

on agency conflict, agency theory ignores CEOs' personal attitude to power and their personality traits, which may be affected by that power. In fact, there is a corpus of psychological research studies that show that one's personality traits indeed may be influenced by the experience of power, which changes a person's behavior pattern.

In their studies of CEO power and bank risk-taking, K.B. Lewellyn and M.I. Muller-Kahle [47] draw the attention to the fact that agency theory ignores the possible impact of power on CEOs' psychological processes. The authors rely on results of D. Keltner et al. [8] and C. Anderson and A.D. Galinsky [50], who point out that those in power tend to pay more attention to positive outcomes, discounting possible threats. These results are also supported by the findings of M.E. Inesi [51], which indicate that power reduces loss aversion; moreover, results suggest that power holders are less risk averse as well. N.J. Fast et al. [52] complemented these results by showing that the experience of power can lead to overconfidence in decision-making or, more specifically, to overestimation of the accuracy of one's own knowledge. Additionally, power can affect people's behavior, leading to an overestimation of their own initial judgment, and making the most powerful people the least accurate in their assessments [53]. It is reasonable to assume now that above-described relationship between power and overconfidence found in psychological research holds in the corporate context as well.

The problem of overconfidence as a CEO personality trait is proposed and first documented in the study by U. Malmendier and G. Tate [54]. The authors argue that overconfident managers overestimate the returns on their investment projects and found that investment-cash flow sensitivity is affected by CEO overconfidence. Of particular interest for our study is the work of H. Hwanga et al. [55]. Based on the psychological observation that power can induce overconfidence, the authors argue and empirically test the hypothesis that CEO power may be the source of CEO overconfidence. Their results support the general findings of N.J. Fast et al. [52], who revealed a causal relationship between overconfidence and power, specifically pointing out that the latter increases the former. Moreover, H. Hwanga et al. [55] identify two types of overconfidence: power-led overconfidence and personality-led overconfidence. Connecting their own findings and conclusions in existing literature on overconfident CEO behavior in M&A, the author argues that previous studies typically depict power-led overconfident CEOs. As a result, H. Hwang et al. [55] show that power-led overconfident CEOs tend to complete more deals regardless of economic circumstances, conduct stock acquisitions, and acquire diversified assets. From another point of view, I. Vitanova [56] documented that power-induced overconfidence has a positive impact on overall corporate performance.

Overconfidence is not the only power-related trait, in fact, hubris is probably the most power-affected personality trait. It is one of the human cognitive biases, which is characterized by exaggerated self-confidence and pride [57]. It should be noted that even though overconfidence is usually observed among persons with hubristic behavior, the two traits still differ. While overconfidence depicts an excessive degree of confidence, hubris reflects a person's presumptions and arrogance [i.e., towards gods in Greek myths]. Describing the "hubris syndrome," D. Owen [58] declares that hubris is inextricably linked to power, that power is an important prerequisite and when it wanes, the syndrome weakens as well. Under certain circumstances, in particular the experience of power, hubristic leaders become "intoxicated" by it and grow overconfident, overestimating the probability of successful outcome and discounting possible threats [59]. Powerful CEOs are probably the most likely candidates for the hubris syndrome to emerge. It is therefore not surprising that the combination of CEO power and CEO hubris found its representation in empirical research. Specifically, J.H. Park et al. [57] demonstrate that CEO power exacerbates the negative impact of CEO hubris on Korean firms. While hubris by itself makes CEO overestimate possible positive outcomes and underestimate negative ones, as well as discount advice from others, power and its entrenchment provides decision-making authority and resources to undertake value-destroying projects. However, results suggest that board vigilance can mitigate this negative effect. D. Cormier at al. [60] also document the negative effect of hubristic and powerful CEOs in connection with financial misreporting. In contrast, their results point out that governance mechanisms, in particular board independence, are ineffective in mediating this relationship.

Another personality trait that psychologists link to power is narcissism. Unlike hubris, which is more of a state-like phenomena, narcissism is more similar to a personality trait, meaning that power is not a mandatory condition for the emergence of narcissism [59]. Narcissism in psychology is described as a "multifaceted personality trait encompassing individual differences in feelings of grandiosity and entitlement and in strivings for attention and superiority" [61]. In this case, power is a fantasy, a source of constant supply of attention, admiration, and recognition for a narcissistic person [62]. Accordingly, narcissists strive for power and can subsequently abuse power to achieve personal needs. The key driver for power abuse is self-intoxication, unlike the power intoxication in case of hubris [59]. This fact may have implications for agency theory that connects CEO power and extraction of resources for personal needs (in case the CEO is narcissistic). Therefore, while narcissism is not dependent on power, power is an important and desired tool in the hand of a narcissistic person. In a corporate context, for example, D.H. Zhu and G. Chen [63] showed that narcissistic CEOs with power are likely to appoint new directors to the board who have similar narcissistic tendencies. The authors argue that such CEOs may expect that similarity in narcissistic inclinations among new directors can decrease the level of uncertainty in the directors' support of CEOs' leadership and decisions.

Overall, based on psychological studies we can conclude that power can have an impact on a person's behavior. Power can act as both the underlying condition for traits

to emerge or develop (in the case of overconfidence or hubris), as well as the enhancement factor (in case of narcissism). In a corporate context, such patterns are also observed and documented, meaning that CEOs' personal traits may be also dependent on their level of power.

CEO personality traits and risk-taking

It is important for any company to understand the factors that affect corporate decisions, especially those related to risk-taking. Corporate risk preferences and risk-taking are crucial for the decision-making process and affect firm growth, survival, and performance [64; 65]. According to agency theory, in comparison with managers, company shareholders prefer to take higher risks when those risks are associated with positive project returns, because shareholders may diversify risks [9]. If managerial interests are in line with the interests of shareholders, corporate risk-taking will yield benefits. However, if there is a misalignment of managerial beliefs with shareholders' ones, additional risk may be harmful for the firm.

According to T.B. Palmer and R.M. Wiseman [66], it is important to separate managerial [personal] risk-taking from corporate risk-taking, although the latter may be affected by the former. Personal risk-taking is rooted in personal traits, perceptions of and beliefs about future outcomes, whereas corporate risk-taking mostly refers to the overall implementation of a company's long-term strategies [67; 68]. A huge corpus of literature in applied psychology demonstrates the need to examine the effect of different personality dimensions on managerial decision-making through perceived threat, optimism, reaction to gains and losses and high uncertainty [69–73]. Attributes such as gender, age and personality were found to affect an individual's risk propensity [74; 75], resulting in different personal risk-taking patterns [67]. An understanding of differences in individual risk perception, which depends on variability of personalities, may explain the differences in companies' risk profiles and risk-taking decisions [76].

The relationship between personality traits and risk-taking has been already partially discussed earlier. Risk-taking characterizes a choice pattern of a person who decides whether to receive a guaranteed outcome or to play lottery with equal expected values [77]. Figner and Weber [77] point out that risk-taking is dependent on the characteristics of the decision maker, as well as on the decision domain. The authors argue that person-centered characteristics such as age, gender, personality, and culture have an impact on risk-perception – an important factor for risk-taking.

W.K. Campbell et al. [78] specifically analyze how narcissism relates to risk-taking. The authors draw the attention to the fact that narcissists fail in two areas: accurate assessment of their own abilities and appropriate strivings to success. Thus, self-overconfidence and focus on successful outcomes with little fear of failure. It is reasonable to assume that narcissists may take additional risks, driven by the overwhelming expectation of possible narcissistic supply flow in case of a successful outcome. This assumption is supported by the study of J.D. Foster et al. [79], who showed that narcissistic risk-taking is fueled by increased expectations of benefits stemming from risky behaviors.

In a corporate context, narcissism provides CEOs with situational incentives, which are then transformed into their decisions and have an overall effect on a company's strategic and investment plans [80]. Previous research on narcissism established that narcissistic executives, compared with their non-narcissistic colleagues, manifest themselves as more talented people with greater levels of creativity and leadership attributes [81–83]. Consequently, narcissistic CEOs base their decisions on a biased expectation that their performance will be better than that of others, and assume that they will reach guaranteed success in each of the tasks [78]. However, such cognitive bias may result in the overestimation of problem-solving capabilities and the underestimation of risky ventures and the firm's levels of uncertainty [84]. To satisfy their need for admiration, narcissistic executives get involved in risky activities, which highlight their superiority and place them in the center of attention [85; 86]. Moreover, when corporate strategies include innovative projects, narcissistic CEOs with higher influence on corporate decisions prefer to be engaged in high-risk projects [87]. Thus, power is an important attribute for this leader type, and they use their power in order to fulfil their strong desires [88]. That is why, from the above-described perspective, we expect to discover a positive relationship between CEO narcissism and personal risk-taking, as well as a positive relationship between CEO power and CEO risk-taking. On the other hand, the persistent need for a confirmation of their self-view may lead narcissistic CEOs to less risk-taking, because they may fear criticism of useless and unsuccessful initiatives [89]. In line with these thoughts, A. Agnihotri and S. Bhattacharya [90] show that risky decisions, such as firm internationalization, are related to CEO narcissism. The authors point that while other CEOs may see risk and uncertainty in risky decisions, i.e., internationalization, narcissistic CEOs may rely on bold and aggressive decisions by virtue of their personality and supreme self-confidence.

As discussed earlier, in addition to narcissism, overconfidence can have an impact on risk-taking. The prefix "over" already reveals an expectation of a certain assessment bias. Based on existing psychological literature, D.A. Moore and P.J. Healy [91] highlighted the three key ways of defining overconfidence, namely overprecision, overplacement, and overestimation. All these three elements imply that a person overestimates their accuracy or abilities compared to themselves or others. Thus, in case of risk-taking, overconfidence may have an impact on risk-perception, leading to greater risk-taking. While a narcissistic person may take additional risks because of their striving for success, an overconfident person may rely on their inflated expectation of successful outcome probability [or low risk-percep-

tion]. M.H. Broihanne et al. [92] show that among finance professionals, overconfidence and underestimation of risk play a crucial role in explaining risk-taking decisions, more specifically, that overconfidence has a positive impact on risk-taking behavior.

In addition to psychological characteristics, existing studies provide empirical evidence of the relationship between CEO risk-taking and demographic traits. Such traits include education [93–96], professional experience [93], early-life traumatic experience [11; 97–99], birth order [10–102], tenure [93; 103] and age [104–111]. For the purposes of our research, the above-mentioned personality traits are not of particular interest, since they are unlikely to be affected by CEO power. However, we can assume that power use may be dependent on CEO experience, age, or tenure, and there is still insufficient literature coverage of this issue.

CEO power, personality traits and risk-taking

Agency theory predicts that CEO power has a negative impact on corporate risk-taking. On the one hand, unlike shareholders, CEOs cannot diversify risks since their assets and wealth are directly connected to the firm they manage. On the other hand, agency conflict implies that CEOs are prone to extract personal benefits at the expenses of shareholders. Effects of these motives on corporate performance are expected, so that companies with powerful CEOs will have lower leverage [46], lower R&D expenses [37], etc. However, as already stated, agency theory, which views CEOs as economic agents, assumes that CEOs are homogenous in power use and, more importantly, ignores heterogeneity in CEOs personality traits.

Up until now we have considered the relationship between CEO power, personal traits and risk-taking behavior independently to prepare the ground for their further consolidation. Based on the existing studies, we are proposing that CEO power may be one of the factors affecting CEO risk-taking. Still, this relationship may be an indirect one, with personal traits being the key intermediate point. On the one hand, CEOs' power can affect their personality traits, producing or enhancing them. On the other hand, CEOs' personality traits affect their risk-taking behavior both by changing their perception of risk, and by means of behavior patterns inherent in those traits. Either way, this relationship expands the existing theories, which connect CEOs' power and risk-taking, including corporate risk-taking.

These findings force us to revise the existing studies linking CEO power and CEO personal and corporate risk-taking, especially those with contradictory results. The fact that power can affect a person's psychological processes and engage with personality traits has implications for empirical research. It is reasonable to assume that CEO narcissism, overconfidence and hubris may be significant mediators in the relationship between CEO power and corporate decisions, especially those that require risk-taking. The same is expected for the impact of personal traits on corporate decisions, since power can act as a mediator [enhancer] of the influence of personal traits. Inclusion of such variables will allow us to account for the heterogeneity of CEOs' behavior, their motives, risk attitude, and power use patterns.

Several limitations are worth noting. First, in this study we do not address the question of possible moderators of the power–traits–risk-taking relationship. From literature on corporate governance we know that the corporate board, exchange regulation and market conditions can act as significant mediators of CEO power [43; 112–114]. At the same time, studies demonstrate that personality traits may also be affected by external conditions. For example, A. Chatterjee and D.C. Hambrick [80] found that risk-taking behavior of narcissistic CEOs is highly dependent on social praise. Thus, the impact of such mediators may yield interesting results. Secondly, as it was stated in the second part, risk-taking decisions are dependent on the personal characteristics of the decision maker and the decision domain. While the relationship between personality traits and risk-taking is explained in the second part, decision domain remained out of the scope of discussion. Considering the high level of CEOs' responsibility to shareholders for corporate performance, as well as the possible pressure from the market environment, the relationships between power, personality traits and risk-taking observed in psychological studies may not be applicable for CEOs. Still, there is no evidence of that, so this is a limitation and an opportunity for future research. Lastly, we assume that CEO power indirectly affects CEO personal risk-taking, with personality traits being an intermediate factor. However, we do not rule out the possibility that CEO power may have a direct impact on risk-taking. Empirical testing would shed the light on this, but in order to test this relationship, we must correctly assess the level of CEOs' personal risk-taking, which is highly problematic. Thus, we are leaving this question for future research.

Conclusion

Existing studies on CEO power and corporate risk-taking mostly rely on assumptions of agency theory, which ignores the heterogeneity of CEO power use, as well as the CEO personality. Motivated by these shortcomings, our study aims to address these questions by analyzing relevant managerial and psychological literature. We hypothesize that a CEO's personal risk-taking [which, in turn, has an impact on corporate risk-taking] may be dependent on CEO power, with CEO personality traits being intermediate point. Results of psychological studies show that power can affect a person's risk behavior, causing overconfident conduct or nurturing narcissism and other traits. Managerial studies contribute to the common psychological view and depict these patterns among CEOs in real-life situations.

These findings have implications for empirical research in the field of corporate decisions, performance, and corporate governance. There are some limitations still, but together with results they provide ground for future research.

References

1. Amihud Y., Lev B. Risk reduction as a managerial motive for conglomerate mergers. *The Bell Journal of Economics*.1981;12(2):605-617. https://doi.org/10.2307/3003575
2. Eisenhardt K.M. Building theories from case study research. *The Academy of Management Review*. 1989;14(4):532-550. https://doi.org/10.2307/258557
3. Jensen M.C., Meckling W.H. Theory of the firm: Managerial behavior, agency costs and ownership structure. *Journal of Financial Economics*. 1976;3(4):305-360. https://doi.org/10.1016/0304-405X(76)90026-X
4. Wiseman R.M., Gomez-Mejia L.R. A behavioral agency model of managerial risk taking. *The Academy of Management Review*. 1998;23(1):133-153. https://doi.org/10.2307/259103
5. Finkelstein S., Hambrick D.C., Cannella A.A. Jr. Strategic leadership: Theory and research on executives, top management teams and boards. Oxford: Oxford University Press; 2009. 463 p.
6. Carpenter M.A., Pollock T.G., Leary M.M. Testing a model of reasoned risk-taking: Governance, the experience of principals and agents, and global strategy in high-technology IPO firms. *Strategic Management Journal*. 2003;24(9):803-820. https://doi.org/10.1002/smj.338
7. Sanders W.G., Hambrick D.C. Swinging for the fences: The effects of CEO stock options on company risk taking and performance. *The Academy of Management Journal*. 2007;50(5):1055-1078. https://doi.org/10.2307/20159913
8. Keltner D., Gruenfeld D.H., Anderson C. Power, approach, and inhibition. *Psychological Review*. 2003;110(2):265-284. https://doi.org/10.1037/0033-295X.110.2.265
9. Faccio M., Marchica M.-T., Mura R. Large shareholder diversification and corporate risk-taking. *The Review of Financial Studies*. 2011;24(11):3601-3641. https://doi.org/10.1093/rfs/hhr065
10. Hiller N.J., Hambrick D.C. Conceptualizing executive hubris: the role of (hyper-) core self-evaluations in strategic decision-Making. *Strategic Management Journal*. 2005;26(4):297-319.
11. Malmendier U., Tate J., Yan J. Overconfidence and early-life experiences: the effect of managerial traits on corporate financial policies. *The Journal of Finance*. 2011;66(5):1687-1733. https://doi.org/10.1111/j.1540-6261.2011.01685.x
12. Efraim B., Frydman C. Military CEOs. *Journal of Financial Economics*. 2015;117(1):43-59. https://doi.org/10.1016/j.jfineco.2014.04.009
13. Hutton S.B., Nolte S. The effect of gaze cues on attention to print advertisements. *Applied Cognitive Psychology*. 2011;25(6):887-892. https://doi.org/10.1002/acp.1763
14. Hirshieifer D., Low A., Teoh W.S. Are overconfident CEOs better Innovators? *The Journal of Finance*. 2012;67(4):1457-1498. https://doi.org/10.1111/j.1540-6261.2012.01753.x
15. Campello M., Graham J.R., Harvey C.R. The real effects of financial constraints: Evidence from a financial crisis. *Journal of Financial Economics*. 2010;97(3):470-487. https://doi.org/10.1016/j.jfineco.2010.02.009
16. Cain M.D., McKeon S.B. CEO personal risk-taking and corporate policies. *Journal of Financial and Quantitative Analysis*. 2012;51(1):139-164. https://doi.org/10.1017/S0022109016000041
17. Li H., Zhang Y. The role of managers' political networking and functional experience in new venture Performance: Evidence from China's transition economy. *Strategic Management Journal*. 2007;28(8):791-804. https://doi.org/10.1002/smj.605
18. Custódio C., Metzger D. Financial expert CEOs: CEO's work experience and firm's financial policies. *Journal of Financial Economics*. 2014;114(1):125-154. https://doi.org/10.1016/j.jfineco.2014.06.002
19. Nicolosi G., Yore A.S. "I do": Does marital status affect how much CEOs "do"? *The Financial Review*. 2015;50(1):57-88. http://dx.doi.org/10.1111/fire.12060
20. Quigley T.J., Hambrick D.C. When the former CEO stays on as board chair: Effects on successor discretion, strategic change, and performance. *Strategic Management Journal*. 2012;33(7):834-859. https://doi.org/10.1002/smj.1945
21. Magee J.C., Galinsky A.D. Social hierarchy: The self-reinforcing nature of power and status. *The Academy of Management Annals*. 2008;2(1):351-398. https://doi.org/10.1080/19416520802211628
22. Karniol R., Ross M. The motivational impact of temporal focus: thinking about the future and the past. *Annual Review of Psychology*. 1996;47:593-620. https://doi.org/10.1146/annurev.psych.47.1.593
23. Maner J.K., Gailliot M.T., Butz D.A., Peruche M. Power, risk, and the status quo: Does power promote riskier or more conservative decision making? *Personality and Social Psychology Bulletin*. 2007;33(4):451-462. https://doi.org/10.1177/0146167206297405
24. Bigley G.A., Wiersema M.F. New CEOs and corporate strategic refocusing: How experience as heir apparent influences the use of power. *Administrative Science Quarterly*. 2002;47(4):707-727. https://doi.org/10.2307/3094914

25. Child J. Organizational structure, environment and performance: The role of strategic choice. *Sociology*. 1972;6(1):1-22. https://doi.org/10.1177/003803857200600101

26. Daily C.M., Johnson J.L. Sources of CEO power and firm financial performance: A longitudinal assessment. *Journal of Management*. 1997;23(2):97-117. https://doi.org/10.1016/S0149-2063(97)90039-8

27. Harjoto M.A., Jo H. CEO power and firm performance: A test of the life-cycle theory. Vol. 38, *Asia-Pacific Journal of Financial Studies*. 2009;38(1):35-66. https://doi.org/10.1111/j.2041-6156.2009.tb00007.x

28. Ting H.I., Chueh H., Chang P.-R. CEO power and its effect on performance and governance: Evidence from Chinese banks. *Emerging Markets Review*. 2017;33:42-61. https://doi.org/10.1016/j.ememar.2017.09.005

29. Fang H., Lee J.-S., Chung C.-P., Lee Y.-H., Wang W.-H. Effect of CEO power and board strength on bank performance in China. *Journal of Asian Economics*. 2020;69:101215. https://doi.org/10.1016/j.asieco.2020.101215

30. Chiu J., Chen C.-H., Cheng C.-C., Hung S.-C. Knowledge capital, CEO power, and firm value: Evidence from the IT industry. *The North American Journal of Economics and Finance*. 2021;55:101012. https://doi.org/10.1016/j.najef.2019.101012

31. Wu S., Quan X., Xu L. CEO power, disclosure quality and the variability of firm performance: Evidence from China. *Nankai Business Review International*. 2011;2(1):79-97. https://doi.org/10.1108/20408741111113510

32. Breit E., Song X.(J.), Sun L., Zhang J. CEO power and labor productivity. *Accounting Research Journal*. 2019;32(2):148-165. https://doi.org/10.1108/ARJ-05-2016-0056

33. Bahloul W., Hachicha N., Bouri A. Modeling the effect of CEO power on efficiency: Evidence from the European non-life insurance market. *Journal of Risk Finance*. 2013;14(3):266-285. https://doi.org/10.1108/JRF-11-2012-0077

34. Huang J., Jain B.A., Shao Y. CEO power, product market competition and the acquisition motive for going public. *Accounting and Finance*. 2019;59(4):2479-2507. https://doi.org/10.1111/acfi.12316

35. Dutta S., MacAulay K., Saadi S. CEO power, M&A decisions, and market reactions. *Journal of Multinational Financial Management*. 2011;21(5):257-278. https://doi.org/10.1016/j.mulfin.2011.07.003

36. Gong N., Guo L. CEO power and mergers and acquisitions. *SSRN Electronic Journal*. 2014. https://doi.org/10.2139/ssrn.2404952

37. Naaman C., Sun L. CEO power and R&D investment. *Accounting Research Journal*. 2021. https://doi.org/10.1108/arj-07-2020-0195

38. Sariol A.M., Abebe M.A. The influence of CEO power on explorative and exploitative organizational innovation. *Journal of Business Research*. 2017;73:38-45. https://doi.org/10.1016/j.jbusres.2016.11.016

39. Onali E., Galiakhmetova R., Molyneux P., Torluccio G. CEO power, government monitoring, and bank dividends. *Journal of Financial Intermediation*. 2016;27:89-117. https://doi.org/10.1016/j.jfi.2015.08.001

40. Chintrakarn P., Chatjuthamard P., Tong S., Jiraporn P. How do powerful CEOs view dividends and stock repurchases? Evidence from the CEO pay slice (CPS). *International Review of Economics and Finance*. 2018;58:49-64. https://doi.org/10.1016/j.iref.2018.02.023

41. Abebe M.A., Angriawan A., Liu Y. CEO power and organizational turnaround in declining firms: Does environment play a role? *Journal of Leadership and Organizational Studies*. 2011;18(2):260–73. https://doi.org/10.1177/1548051810385004

42. Al Mamun M., Balachandran B., Duong H.N. Powerful CEOs and stock price crash risk. *Journal of Corporate Finance*. 2020;62;101582. https://doi.org/10.1016/j.jcorpfin.2020.101582

43. Sheikh S. CEO power and corporate risk: The impact of market competition and corporate governance. *Corporate Governance: An International Review*. 2019;27(5):358-377. https://doi.org/10.1111/corg.12285

44. Pathan S. Strong boards, CEO power and bank risk-taking. *Journal of Banking and Finance*. 2009;33(7):1340-1350. https://doi.org/10.1016/j.jbankfin.2009.02.001

45. Chao C.C., Hu M., Munir Q., Li T. The impact of CEO power on corporate capital structure: New evidence from dynamic panel threshold analysis. *International Review of Economics and Finance*. 2017;51:107-120. https://doi.org/10.1016/j.iref.2017.05.010

46. Munir Q., Li T. Nonlinearity between CEO power and firm leverage: evidence from the threshold model. *Review of Managerial Science*. 2018;12(3):593-620. https://doi.org/10.1007/s11846-016-0224-x

47. Lewellyn K.B., Muller-Kahle M.I. CEO power and risk taking: Evidence from the subprime lending industry. *Corporate Governance: An International Review*. 2012;20(3):289-307. https://doi.org/10.1111/j.1467-8683.2011.00903.x

48. Altunbaş Y., Thornton J., Uymaz Y. The effect of CEO power on bank risk: Do boards and institutional investors matter? *Finance Research Letters*. 2020;33:101202. https://doi.org/10.1016/j.frl.2019.05.020

49. Romano M., Cirillo A., Mussolino D., Pennacchio L. CEO career horizons and when to go public: The relationship between risk-taking, speed and CEO power. *Journal of Management and Governance*. 2019;23(1):139-163. https://doi.org/10.1007/s10997-017-9398-0

50. Anderson C., Galinsky A.D. Power, optimism, and risk-taking. *European Journal of Social Psychology*. 2006;36(4):511-536. https://doi.org/10.1002/ejsp.324

51. Inesi M.E. Power and loss aversion. *Organizational Behavior and Human Decision Processes*. 2010;112(1):58-69. https://doi.org/10.1016/j.obhdp.2010.01.001

52. Fast N.J., Sivanathan N., Mayer N.D., Galinsky A.D. Power and overconfident decision-making. *Organizational Behavior and Human Decision Processes*. 2012;117(2):249-260. https://doi.org/10.1016/j.obhdp.2011.11.009

53. See K.E., Morrison E.W., Rothman N.B., Soll J.B. The detrimental effects of power on confidence, advice taking, and accuracy. *Organizational Behavior and Human Decision Processes*. 2011;116(2):272-285. https://doi.org/10.1016/j.obhdp.2011.07.006

54. Malmendier U., Tate G. CEO overconfidence and corporate investment. *The Journal of Finance*. 2005;60(6):2661-2700. https://doi.org/10.1111/j.1540-6261.2005.00813.x

55. Hwang H.(D.), Kim H.-D., Kim T. The blind power: Power-led CEO overconfidence and M&A decision making. *The North American Journal of Economics and Finance*. 2020;52:101141. https://doi.org/10.1016/j.najef.2019.101141

56. Vitanova I. Nurturing overconfidence: The relationship between leader power, overconfidence and firm performance. *Leadership Quarterly*. 2021;32(4):101342. https://doi.org/10.1016/j.leaqua.2019.101342

57. Park J.H., Kim C., Chang Y.K., Lee D.H., Sung Y.D. CEO hubris and firm performance: Exploring the moderating roles of CEO power and board vigilance. *Journal of Business Ethics*. 2018;147(4):919-933. https://doi.org/10.1007/s10551-015-2997-2

58. Owen D. Hubris syndrome. *Clinical Medicine*. 2008;8(4):428-432. https://doi.org/10.7861/clinmedicine.8-4-428

59. Asad S., Sadler-Smith E. Differentiating leader hubris and narcissism on the basis of power. *Leadership*. 2020;16(1):39-61. https://doi.org/10.1177/1742715019885763

60. Cormier D., Lapointe-Antunes P., Magnan M. CEO power and CEO hubris: A prelude to financial misreporting? *Management Decision*. 2016;54(2):522-554. https://doi.org/10.1108/MD-04-2015-0122

61. Zeigler-Hill V., Shackelford T.K., eds. Encyclopedia of personality and individual differences. Cham: Springer-Verlag; 2020. 5938 p.

62. Byun K.A., Al-Shammari M. When narcissistic CEOs meet power: Effects of CEO narcissism and power on the likelihood of product recalls in consumer-packaged goods. *Journal of Business Research*. 2021;128:45-60. https://doi.org/10.1016/j.jbusres.2021.02.001

63. Zhu D.H., Chen G. Narcissism, director selection, and risk-taking spending. *Strategic Management Journal*. 2015;36(13):2075-2098. https://doi.org/10.1002/smj.2322

64. Bromiley P. Testing a causal model of corporate risk taking and performance. *The Academy of Management Journal*. 1991;34(1):37-59. https://doi.org/10.2307/256301

65. Shapira Z. Risk taking: A managerial perspective. New York: Russell Sage Foundation; 1995. 174 p.

66. Palmer T.B., Wiseman R.M. Decoupling risk taking from income stream uncertainty: A holistic model of risk. *Strategic Management Journal*. 1999;20(11):1037-1062. https://doi.org/10.1002/(SICI)1097-0266(199911)20:11<1037::AID-SMJ67>3.0.CO;2-2

67. Das T.K., Teng B.-S. Trust, control, and risk in strategic alliances: An integrated framework. *Organization Studies*. 2001;22(2):251-283. https://doi.org/10.1177/0170840601222004

68. Kim K.-H., Buchanan R. CEO duality, leadership and firm risk-taking propensity. *Journal of Applied Business Research*. 2008;24(1):27-41. https://doi.org/10.19030/jabr.v24i1.1364

69. Bono J.E., Judge T.A. Personality and transformational and transactional leadership: A meta-analysis. *Journal of Applied Psychology*. 2004;89(5):901-910. https://doi.org/10.1037/0021-9010.89.5.901

70. Boudreau J.W., Boswell W.R., Judge T.A. Effects of personality on executive career success in the United States and Europe. *Journal of Vocational Behavior*. 2001;58(1):53-81. https://doi.org/10.1006/jvbe.2000.1755

71. Judge T.A., Bono J.E. Five-factor model of personality and transformational leadership. *Journal of Applied Psychology*. 2000;85(5):751-765. https://doi.org/10.1037/0021-9010.85.5.751

72. Judge T.A., Bono J.E., Ilies R., Gerhardt M.W. Personality and leadership: A qualitative and

quantitative review. *Journal of Applied Psychology*. 2002;87(4):765-780. https://doi.org/10.1037/0021-9010.87.4.765

73. Peterson R.S., Smith D.B., Martorana P.V., Owens P.D. The impact of chief executive officer personality on top management team dynamics: One mechanism by which leadership affects organizational performance. *Journal of Applied Psychology*. 2003;88(5):795-808. https://doi.org/10.1037/0021-9010.88.5.795
74. Nicholson N., Soane N., Fenton-O'Creevy M., Willman P. Personality and domain-specific risk taking. *Journal of Risk Research*. 2005;8(2):157-176. https://doi.org/10.1080/1366987032000123856
75. Börjesson M., Österberg J., Enander A. Risk propensity within the military: a study of Swedish officers and soldiers. *Journal of Risk Research*. 2015;18(1):55-68. https://doi.org/10.1080/13669877.2013.879489
76. Peterson G.D., Carpenter S.R., Brock W.A. Uncertainty and the management of multistate ecosystems: An apparently rationale route to collapse. *Ecology*. 2003;84(6):1403-1411. https://doi.org/10.1890/0012-9658(2003)084[1403:UATMOM]2.0.CO;2
77. Figner B., Weber E.U. Personality and risk taking. In: Wright J.D., ed. International encyclopedia of the social & behavioral sciences. 2nd ed. Amsterdam: Elsevier; 2015:809-813.
78. Campbell W.K., Goodie A.S., Foster J.D. Narcissism, confidence, and risk attitude. *Journal of Behavioral Decision Making*. 2004;17(4):297-311. https://doi.org/10.1002/bdm.475
79. Foster J.D., Shenesey J.W., Goff J.S. Why do narcissists take more risks? Testing the roles of perceived risks and benefits of risky behaviors. *Personality and Individual Differences*. 2009;47(8):885-889. https://doi.org/10.1016/j.paid.2009.07.008
80. Chatterjee A., Hambrick D.C. Executive personality, capability cues, and risk taking: How narcissistic CEOs react to their successes and stumbles. *Administrative Science Quarterly*. 2011;56(2):202-237. https://doi.org/10.1177/0001839211427534
81. Farwell L., Wohlwend-Lloyd R. Narcissistic processes: Optimistic expectations, favorable self-evaluations, and self-enhancing attributions. *Journal of Personality*. 1998;66(1):65-83. https://doi.org/10.1111/1467-6494.00003
82. Judge T.A., Scott B.A., Ilie R. Hostility, job attitudes, and workplace deviance: Test of a multilevel model. *Journal of Applied Psychology*. 2006;91(1):126-138. https://doi.org/10.1037/0021-9010.91.1.126
83. Paulhus D.L. Interpersonal and intrapsychic adaptiveness of trait self-enhancement: A mixed blessing? *Journal of Personality and Social Psychology*. 1998;74(5):1197-1208. https://doi.org/10.1037/0022-3514.74.5.1197
84. Li J., Tang Y. CEO hubris and firm risk taking in China: The moderating role of managerial discretion. *The Academy of Management Journal*. 2010;53(1):45-68. https://doi.org/10.5465/amj.2010.48036912
85. Morf C.C., Rhodewalt F. Unraveling the paradoxes of narcissism: A dynamic self-regulatory processing model. *Psychological Inquiry*. 2001;12(4):177-196. https://doi.org/10.1207/S15327965PLI1204_1
86. Wallace H.M., Baumeister R.F. The performance of narcissists rises and falls with perceived opportunity for glory. *Journal of Personality and Social Psychology*. 2002;82(5):819-834. https://doi.org/10.1037//0022-3514.82.5.819
87. Wales W.J., Patel P.C., Lumpkin G.T. In pursuit of greatness: CEO narcissism, entrepreneurial orientation, and firm performance variance. *Journal of Management Studies*. 2013;50(6):1041-1069. https://doi.org/10.1111/joms.12034
88. Campbell J.Y., Hilscher J., Szilagyi J. Predicting financial distress and the performance of distressed stocks. *The Journal of Investment Management*. 2011;(2):1-21.
89. Aabo T., Eriksen N.B. Corporate risk and the humpback of CEO narcissism. *Review of Behavioral Finance*. 2018;10(3):252-273. https://doi.org/10.1108/RBF-07-2017-0070
90. Agnihotri A., Bhattacharya S. CEO Narcissism and internationalization by Indian firms. *Management International Review*. 2019;59(6):889-918. https://doi.org/10.1007/s11575-019-00404-8
91. Moore D.A., Healy P.J. The trouble with overconfidence. *Psychological Review*. 2008;115(2):502-517. https://doi.org/10.1037/0033-295X.115.2.502
92. Broihanne M.H., Merli M., Roger P. Overconfidence, risk perception and the risk-taking behavior of finance professionals. *Finance Research Letters*. 2014;11(2):64-73. https://doi.org/10.1016/j.frl.2013.11.002
93. Farag H., Mallin C. Board diversity and financial fragility: Evidence from European banks. *International Review of Financial Analysis*. 2017;49:98-112. https://doi.org/10.1016/j.irfa.2016.12.002
94. Orens R., Reheul A.M. Do CEO demographics explain cash holdings in SMEs? *European Management Journal*. 2013;31(6):549-563. https://doi.org/10.1016/j.emj.2013.01.003
95. Wang Y. Poutziouris P. Leadership styles, management systems and growth: Empirical

evidence from UK owner-managed SMEs. *Journal of Enterprising Culture*. 2010;18(03):331-354. https://doi.org/10.1142/S0218495810000604

96. Barker V.L., Mueller G.C. CEO characteristics and firm R&D spending. *Management Science*. 2002;48(6):782-801. https://doi.org/10.1287/mnsc.48.6.782.187
97. Malmendier U., Nagel S. Depression babies: Do macroeconomic experiences affect risk taking? *The Quarterly Journal of Economics*. 2011;126(1):373-416. https://doi.org/10.1093/qje/qjq004
98. Bernile G., Bhagwat V., Yonker S. Board diversity, firm risk, and corporate policies. *Journal of Financial Economics*. 2018;127(3):588-612. https://doi.org/10.1016/j.jfineco.2017.12.009
99. Dittmar A., Duchin R. Looking in the rearview mirror: The effect of managers' professional experience on corporate policies. *The Review of Financial Studies*. 2016;29(3):565-602. https://doi.org/10.1093/rfs/hhv051
100. Joo S.-H., Grable J.E. An exploratory framework of the determinants of financial satisfaction. *Journal of Family and Economic Issues*. 2004;25(1):25-50. https://doi.org/10.1023/B:JEEI.0000016722.37994.9f
101. Sulloway F.J., Zweigenhaft R. Birth order and risk taking in athletics: A meta-analysis and study of major league baseball. *Personality and Social Psychology Review*. 2010;14(4):402-416. https://doi.org/10.1177/1088868310361241
102. Campbell R.J., Jeong S.-H., Graffin S.D. Born to take risk? The effect of CEO birth order on strategic risk taking. *The Academy of Management Journal*. 2019;62(4):1278-1306. https://doi.org/10.5465/amj.2017.0790
103. Zahra S.A. Entrepreneurial risk taking in family firms. *Family Business Review*. 2005;18(1):23-40. https://doi.org/10.1111/j.1741-6248.2005.00028.x
104. Yim S. The acquisitiveness of youth: CEO age and acquisition behavior. *Journal of Financial Economics*. 2013;108(1):250-273. https://doi.org/10.1016/j.jfineco.2012.11.003
105. Serfling M.A. CEO age and the riskiness of corporate policies. *Journal of Corporate Finance*. 2014;25:251-273. https://doi.org/10.1016/j.jcorpfin.2013.12.013
106. Li X., Low A., Makhija A.K. Career concerns and the busy life of the young CEO. *Journal of Corporate Finance*. 2017;47:88-109. https://doi.org/10.1016/j.jcorpfin.2017.09.006
107. Child J. Managerial and organizational factors associated with company performance. *Journal of Management Studies*. 1974;11(3):175-189. https://doi.org/10.1111/j.1467-6486.1974.tb00693.x
108. Hambrick D.C., Mason P.A. Upper echelons: The organization as a reflection of its top managers. *The Academy of Management Review*. 1984;9(2):193-206. https://doi.org/10.2307/258434
109. Taylor R.N. Age and experience as determinants of managerial information processing and decision making performance. *The Academy of Management Journal*. 1975;18(1):74-81. https://doi.org/10.2307/255626
110. Simsek Z. CEO Tenure and organizational performance: An intervening model. *Strategic Management Journal*. 2007;28(6):653-662. https://doi.org/10.1002/smj.599
111. Yeoh S.-B., Hooy C.-W. CEO age and risk-taking of family business in Malaysia: The inverse s-curve relationship. *Asia Pacific Journal of Management*. 2020. https://doi.org/10.1007/s10490-020-09725-x
112. Jaroenjitrkam A., Yu C.-F, Zurbruegg R. Does market power discipline CEO power? An agency perspective. *European Financial Management*. 2020;26(3):724-752. https://doi.org/10.1111/eufm.12240
113. Sheikh S. The impact of market competition on the relation between CEO power and firm innovation. *Journal of Multinational Financial Management*. 2018;44:36-50. https://doi.org/10.1016/j.mulfin.2018.01.003
114. Sheikh S. CEO power, product market competition and firm value. *Research in International Business and Finance*. 2018;46:373-386. https://doi.org/10.1016/j.ribaf.2018.04.009

Contribution of the authors: the authors contributed equally to this article.

The authors declare no conflicts of interests.

The article **was submitted** 06.12.2021; **approved after reviewing** 08.01.2022; **accepted for publication** 28.01.2022.