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CONTENTS

Performance Evaluation of the Manufacturing Industry of the Czech Republic According to Multi-Criteria Decision-Making Methods

Martina Borovcová[1], Dagmar Richtarová[2]

Abstract

The contribution is focused on the use of multi-criteria decision-making methods in the evaluation of the financial performance of the manufacturing industry of the Czech Republic using selected ratio indicators. The methodological part presents the evaluated sector, selected ratio indicators (ROE, total indebtedness, degree of coverage by fixed assets, receivables turnover period, liabilities turnover period, current and quick liquidity), and the AHP method with multi-level decomposition. Subsequently, the values of the ratio indicators are determined, and their development is recorded in the years 2013-2022. Indicator values are the basis for evaluating the performance of the manufacturing industry in the Czech Republic according to multicriteria analysis methods. Saaty's Analytical Hierarchy Process method is used in the paper. The results of the provided analysis are commented on at the end.

Key words
MCDM, AHP, criteria, alternative, indicators, the manufacturing industry, financial ratios

JEL Classification: C02, C4, G3, G11

1. Introduction

Evaluating the development of the performance of enterprises and sectors is one of the basic principles of their effective functioning. Financial performance can be evaluated according to different approaches, which differ in the choice of indicators used. Historically, not only accounting but also economic and market indicators were used to analyze performance; see Dluhošová (2021) and Vernimmen (2005). Some studies have looked at how the financial performance of non-financial and financial institutions should be adequately assessed, e.g. using the accounting indicator of return on equity, see Strnadová and Karas (2014). This indicator was used by other authors Chen, Feldman, and Tang (2015), who investigated whether the social performance of companies affects financial performance. The economic indicator EVA (economic value added) as a performance measure has been described in several publications, e.g. Rappaport (1986), Chen and Dodd (1997), and Grant (2003).

Some authors also dealt with the evaluation of the performance of selected industries. For example, Dluhošová (2004) applies the pyramid decomposition of the EVA indicator to selected industries in the Czech Republic and determines the generators of value creation using the analysis of deviations. Richtarová, Ptáčková and Borovcová (2020) apply the pyramid decomposition of the EVA indicator and based on the analysis of deviations, quantify the factors that influence the economic added value of the manufacturing industry in

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the Czech Republic. It is the manufacturing industry that is the primary sector of the economy and is therefore evaluated by several authors, e.g. Ududechinyere and Mbam (2018) emphasize that the manufacturing industry is traditionally one of the key drivers in most national economies; Belgin and Balkan (2020) focus in their study on the evaluation of the environmental performance of manufacturing sectors and Kotane and Mietule (2022) evaluate the performance of manufacturing companies in Latvia.

Performance can be evaluated not only according to selected ratio indicators but also multi-criteria decision-making methods can be used for a more comprehensive evaluation.

The contribution aims to verify the results of the evaluation of the financial performance of the manufacturing industry in the Czech Republic using multicriteria analysis methods. Performance will be evaluated according to selected ratio indicators. Saaty's method of pairwise comparison will then verify the influence of individual indicators. Subsequently, the order of the individual periods will be determined by the detected changes in the indicators and their preferences.

2. Methodology

To fulfill the set goal, perform the analysis and evaluate the performance of the manufacturing industry in the Czech Republic, it is necessary to determine the values of selected ratio indicators, which will be the input data for the application of multi-criteria decision-making methods.

The manufacturing industry is one of the main sources of gross domestic product in the Czech Republic. The manufacturing industry in the Czech Republic is divided into 24 sectors, which have different characteristics. Individual sectors of the manufacturing industry account for 23% of the gross added value. Sector 29 (Manufacture of motor vehicles, t (except motorcycles), trailers and semi-trailers), 26 (Manufacture of computers, electrical and optical products), and 28 (Manufacture of machinery and equipment, etc.) have the largest share of total sales. manufacturing industry. The indicators used for this analysis are return on equity, total indebtedness, degree of coverage of fixed assets, turnover period of receivables, turnover period of payables, current and quick liquidity. The calculation of these indicators is shown in Table 1.

Table 1: Selected ratios

Indicator	Formula	Number of formula
Return on Equity (ROE)	*EAT/Equity*	(1)
Total indebtedness	*Liabilities/Total assets*	(2)
Degree of coverage of fixed assets	*Long-term capital/Fixed assets*	(3)
Turnover period of receivables	*(Revenues/Receivables)·360*	(4)
Turnover period of payables	*(Revenues/Payables)·360*	(5)
Current liquidity	*Current assets/Short-term payables*	(6)
Quick liquidity	*(Current assets-inventory)/Short-term payables*	(7)

The first indicator is the ROE indicator, which evaluates the return on equity. Another indicator is total indebtedness. This indicator evaluates the degree of involvement of liabilities in the financing of assets. The indicator of the degree of coverage of fixed assets is given by the share of long-term capital and fixed assets. Long-term capital includes not only equity but also reserves and long-term liabilities. The value of this indicator indicates the chosen method of asset financing (balanced, aggressive, conservative). If the value of the indicator is equal to 1, then long-term capital is used to finance long-term assets and short-term capital is used to

finance current assets. The receivables turnover period expresses the number of days for which the receivables are paid. A similar indicator is the turnover period of liabilities, which expresses the number of days for which liabilities are paid. Current and quick liquidity indicators evaluate the ability to pay short-term payables.

To evaluate the level of the manufacturing industry, it is first necessary to determine the weights of the criteria, i.e. the indicators. Subsequently, the variants, i.e. the values of the selected ratio indicators for the manufacturing industry in the analyzed years, will be compared in order to be able to evaluate them. Saaty's AHP method will be used in the application part of the study. Therefore, the following description will focus on this method.

The Analytic Hierarchy Process (AHP) method was developed by Thomas L. Saaty. The method is based on a pairwise comparison of criteria or alternatives for solving a multi-criteria decision-making problem while respecting the structure of the decision-making situation.

Multicriteria decision-making (MCDM) is a field that chooses the best of a discrete set of alternatives, Saaty (2009). Unlike the usual methods of optimization that assume the availability of measurements, measurements in MCDM are assumed to be derived or interpreted subjectively as indicators of preference and of the strength of preference. One person´s preference is different than another person´s and thus the outcome depends on who is making the decisions and his/her preferences and goals.

The analytic hierarchy process (AHP) is an MCDM method based on priority theory. It deals with complex problems which involve the consideration of multiple criteria/alternatives simultaneously, Raju and Kumar (2014). The AHP and its generalization to dependence and feedback, the Analytic Network Process (ANP), are methods of relative measurement of intangibles. They can help bring together a diverse group of people with different perspectives to make the complex decisions required in our time. They offer a structured framework for discussion and debate, a way to include the important intangibles of every major decision together with the tangibles, and a way to resolve conflicts and achieve buy-in to implement the decision at the end of the day.

As with any other MCDM method, the decision maker must first be identified, the decision objective established, and the decision problem structured. Subsequently, it is necessary to establish alternatives and determine criteria. Then, based on pairwise comparisons provided by the user, priorities are ranked. The decision maker does not need to provide a numerical judgment, a relative verbal valuation that is more familiar to our everyday life is sufficient. There are two additional steps that can be taken: a consistency check and a sensitivity analysis. Both steps are optional but recommended to confirm the robustness of the results. Consistency checking is common to all pairwise comparison methods like AHP.

The method of weight determination of the criteria can be divided into two steps. The first step consists of a pairwise comparison when finding the preferential relations of criteria pairs. It is presented as the matrix A. This matrix is symmetric with elements $a_{i,j}$. It is possible to determine also the size of this preference expressed by a certain number of points from the selected point scale in addition to the direction of the preference of pair of criteria. The scale of relative importance recommended by Saaty it is shown in Table 2. The strength of preferences is expressed in the interval $a_{i,j} \epsilon$ [0;9]. This step is resulting in obtaining the right upper triangular part of the matrix A:

$$A = \begin{bmatrix} 1 & \cdots & a_{1n} \\ \vdots & \ddots & \vdots \\ 1/a_{1n} & \cdots & 1 \end{bmatrix}, \tag{8}$$

where the diagonal element has to be $a_{i,i}$ = 1, and for the inverse elements (in the lower left triangular part of a matrix) true the following:

$$a_{i,j} = \frac{1}{a_{j,i}}. \tag{9}$$

The elements $a_{i,j}$ matrix are estimated shares of weights of criteria v_i and v_j, so:

$$a_{i,j} \cong \frac{v_i}{v_j}. \tag{10}$$

The scales can be obtained in the following manner:

$$min\ F = \sum_i^n \sum_j^n \left(a_{i,j} - \frac{v_i}{v_j}\right)^2, \tag{11}$$

with the condition $\sum_i^n v_i = 1$.

Because of difficulty, it is possible to obtain the weights using an algorithm based on the geometric average.

$$min\ F = \sum_{i=1}^n \sum_{j>i}^n \left[ln\ a_{i,j} - (ln\ v_i - ln\ v_j)\right]^2, \tag{12}$$

with the condition $\sum_i^n v_i = 1$.

The final solution is based on the geometric mean of rows Saaty (2010):

$$w_i = \frac{v_i}{\sum_i^N v_i} = \frac{\left[\prod_j^N a_{i,j}\right]^{\frac{1}{N}}}{\sum_i^N \left[\prod_j^N a_{i,j}\right]^{\frac{1}{N}}}. \tag{13}$$

The numerical judgments use the fundamental scale of absolute numbers (invariant under the identity transformation). From logarithmic stimulus-response theory that we do not go into here, we learn that a stimulus compared with itself is always assigned the value 1 so the main diagonal entries of the pairwise comparison matrix are all 1. We also learn that we must use integer values for the comparisons. The numbers 3, 5, 7, and 9 correspond to the verbal judgments "moderately more dominant", "strongly more dominant", "very strongly more dominant", and "extremely more dominant" (with 2, 4, 6, and 8 for compromise between the previous values). Reciprocal values are automatically entered in the transpose position.

Table 2: Fundamental scale of absolute numbers

Intensity of Importance	Definition	Explanation
1	Equal importance	Two activities contribute equally to the objective
2	Weak or slight	
3	Moderate importance	Experience and judgment slightly favor one activity over another
4	Moderate plus	
5	Strong importance	Experience and judgment strongly favor one activity over another
6	Strong plus	
7	Very strong or demonstrated importance	An activity is favored very strongly over another; its dominance demonstrated in practice
8	Very, very strong	
9	Extreme importance	The evidence favoring one activity over another is of the highest possible order of affirmation

Source: Saaty (2010), (2012), own processing

The sign of relevant evaluation is the consistency of Saaty's matrix, in other words when the elements satisfy the condition of transitivity the most. It should be emphasized that in many methods this aspect is not accounted. Consistency can be measured using the coefficient of consistency, consistency ratio (CR). To calculate CR is used consistency index (CI) and random index (RI). RI values are listed in Table 3. The coefficient for consistent evaluation should be $CR \leq 0,1$; Saaty (2010). The consistency ratio is calculated as follows

$$CR = CI/RI, \tag{14}$$

where,

$$CI = \frac{\lambda_{max} - n}{n - 1}, \tag{15}$$

where λ_{max} is the maximal eigenvalue Saaty (2012).

Table 3: Random Index

Order	1	2	3	4	5	6	7	8	9	10	11	12	13
RI	0	0	0.52	0.89	1.11	1.25	1.35	1.4	1.45	1.49	1.52	1.54	1.56
First Order Differences		0	0.52	0.37	0.22	0.14	0.10	0.05	0.05	0.04	0.03	0.02	0.02

Source: Saaty (2009)

The last necessary step is the synthesis of the local priorities across all criteria in order to determine the global priority. The historical AHP approach adopts an additive aggregation with normalization of the sum of the local priorities to unity. This type of normalization is called the distributive mode as stated by Ishizaka and Nemery (2013). This additive aggregation is expressed as

$$P_j = \sum_j w_j p_{i,j}, \tag{16}$$

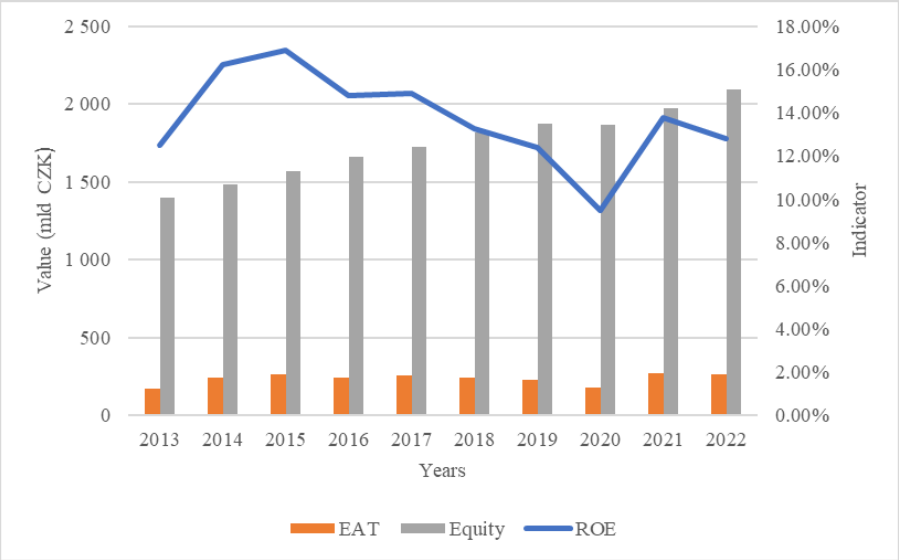
where P_j is the global priority of alternative *i*, $p_{i,j}$ is the local priority with regard to criterion *j*, and w_j is the weight of the criterion *j*.

3. Data

Data from the database of the Ministry of Industry and Trade of the Czech Republic are used to evaluate the financial performance of the manufacturing industry in the Czech Republic. The financial performance of the manufacturing industry will be analyzed for the period 2013-2022 using selected ratios. The development of selected ratios is shown in figures (1-7).

Figure 1 shows the development of ROE in the manufacturing industry.

Figure 1: ROE - the manufacturing industry

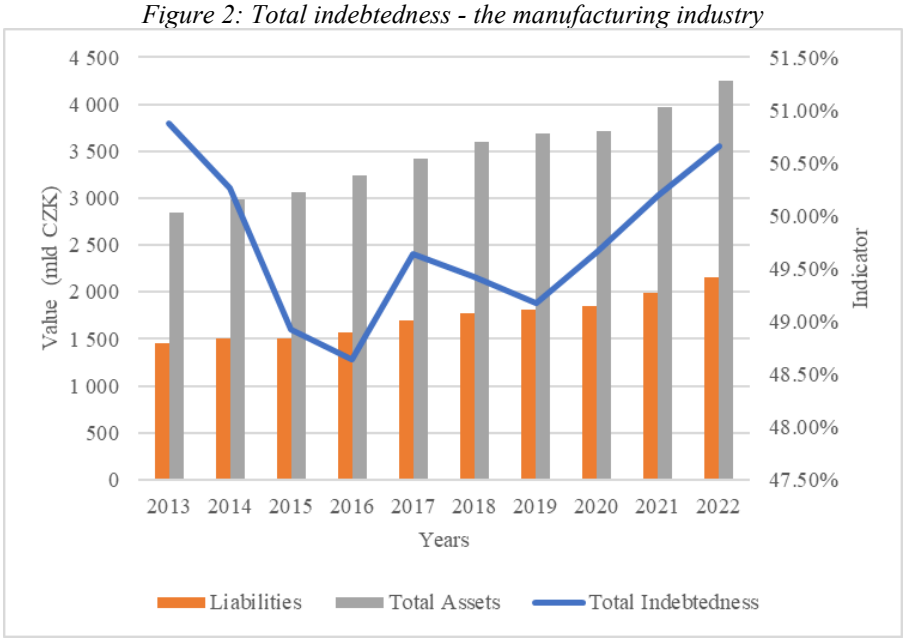


Source: MPO database, own processing

ROE measures the return on equity. The return on equity reached positive values throughout the analyzed period. Equity had the greatest influence on the change in the ROE indicator, which increased year-on-year. Conversely, EAT increased between 2013-2016 and then experienced a significant decline. In 2020, the value of EAT was the lowest, which was caused by the decrease in sales due to the Covid 19 pandemic. In 2021 and 2022, EAT increased due to growth in sales.

The development of total indebtedness is shown in Figure 2.

Figure 2: Total indebtedness - the manufacturing industry

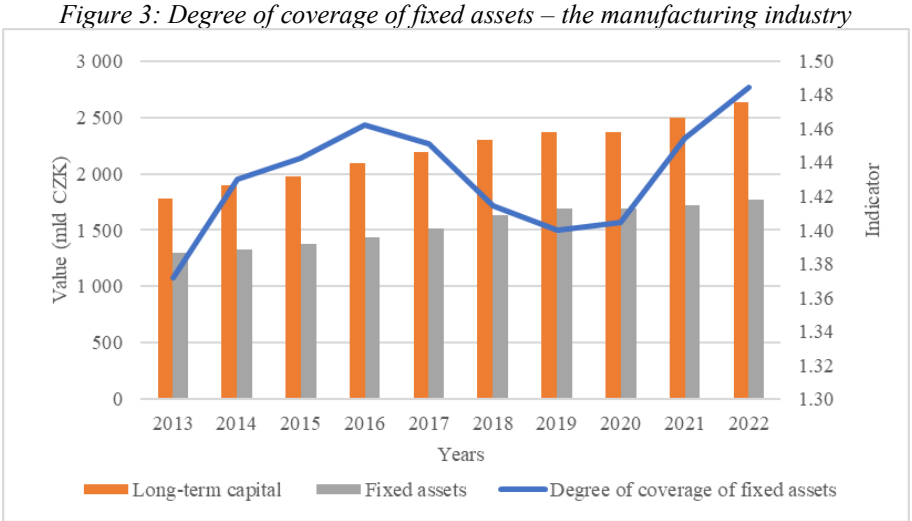


Source: MPO database, own processing

The average indebtedness of the manufacturing industry is 50%. During the analyzed period, not only assets but also liabilities, especially payables, increased.

Another indicator that was used to evaluate the development of the manufacturing industry was the indicator of the degree of coverage by fixed assets. The development of this indicator is shown in the Figure 3.

Figure 3: Degree of coverage of fixed assets – the manufacturing industry



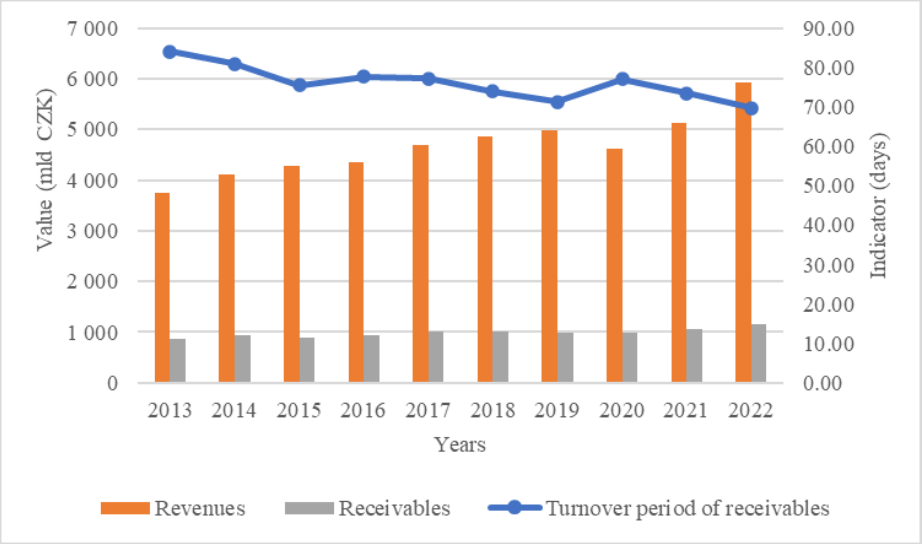
Source: MPO database, own processing

This indicator evaluates the method of financing long-term assets. If the value of the indicator is equal to 1, it means that long-term assets are covered by long-term capital.

Throughout the analyzed period, the indicator showed a value higher than 1. Thus, all sectors of the manufacturing industry use long-term capital not only to finance fixed assets but also as part of current assets. It can be said that a conservative method of financing is used in the manufacturing industry.

Figure 4 shows the development of the receivables turnover period.

Figure 4: Turnover period of receivables – the manufacturing industry

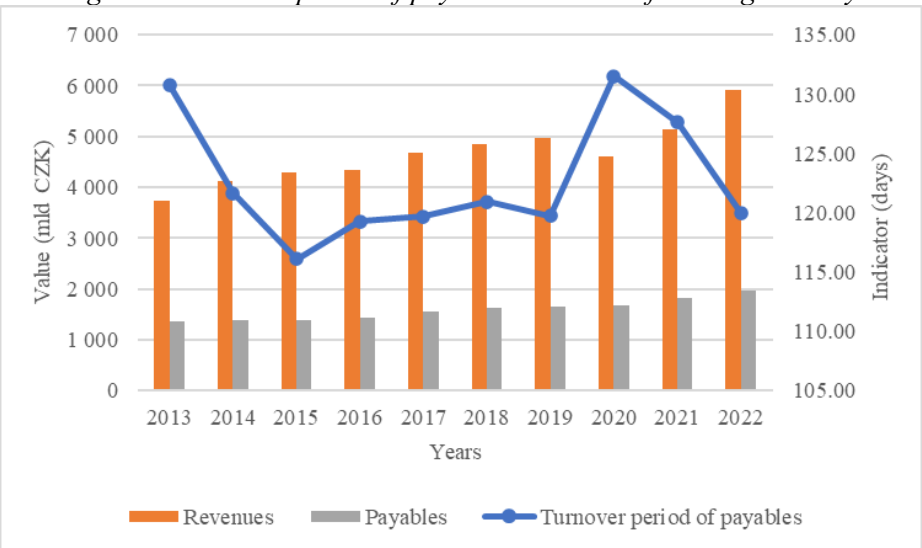


Source: MPO database, own processing

This indicator evaluates how long it takes to repay the total receivables. From the point of view of the trend, the value of this indicator should decrease over time. The downward trend was visible until 2019 when the receivables turnover time was shortened by 13 days. The value of this indicator is significantly influenced by the development of sales, which had an upward trend. Only in 2020 did sales decline, which caused an increase in the receivables turnover time by 5 days compared to 2019. From 2020, the receivables turnover time is being shortened again. During the analyzed period, the receivables turnover time decreased by 15 days, which is a positive trend.

Figure 5 shows the development of another indicator, the turnover period of payables.

Figure 5: Turnover period of payables - the manufacturing industry

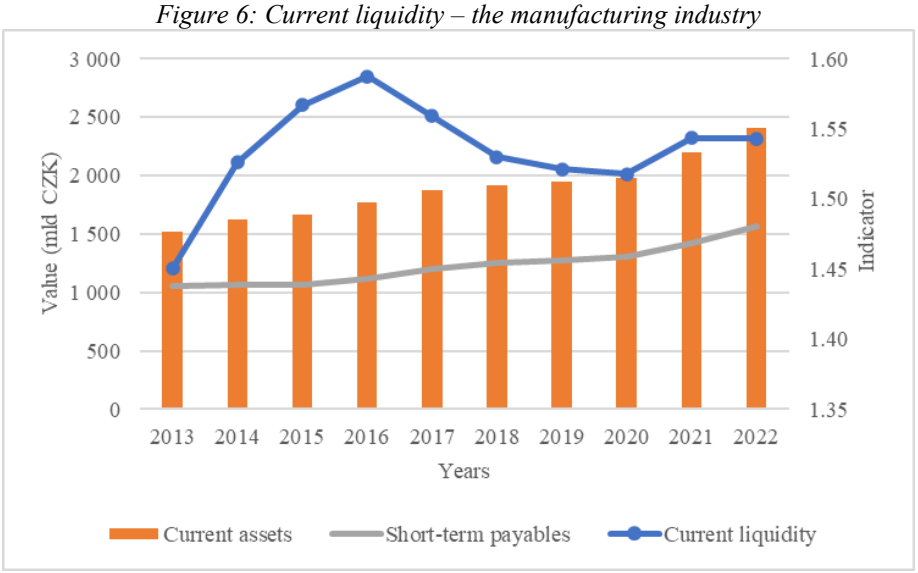


Source: MPO database, own processing

This indicator measures the number of days in which, on average, payables are repaid. The average turnover period of payables is 123 days. To achieve solvency, the receivables turnover period should be shorter than the payables turnover period. The analysis showed that this rule was fulfilled in the manufacturing industry throughout the analyzed period.

The development of the current liquidity indicator is shown in Figure 6.

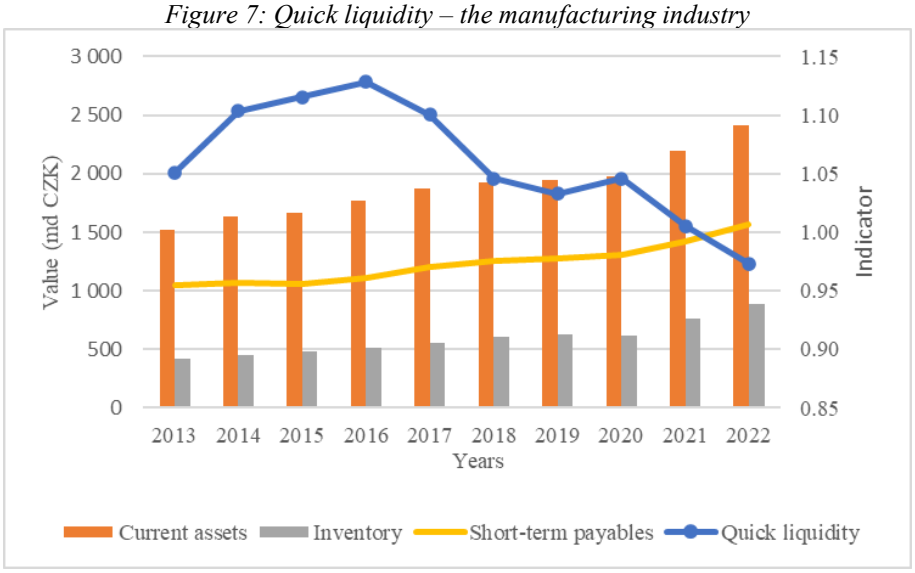
Figure 6: Current liquidity – the manufacturing industry



Source: MPO database, own processing

The current liquidity indicator evaluates the ability of sectors and companies to meet their short-term payables. The manufacturing industry, except for 2013, showed a value of the current liquidity indicator higher than 1.5 throughout the analyzed period. The value of current assets is higher than the value of current liabilities, i.e. liquidity is always maintained in the manufacturing industry. The development of this indicator is in line with the value of the solvency rule.

Figure 7: Quick liquidity – the manufacturing industry



Source: MPO database, own processing

The last indicator used to assess the performance of the manufacturing industry is the quick liquidity ratio. The development of this indicator is shown in Figure 7. In this indicator,

current assets are net of inventories. To achieve liquidity, the value of the indicator should be greater than 1. Except in 2022, the manufacturing industry achieves this value. In 2022, the ratio of inventories to current assets increased to 37%, causing the indicator to fall to a value of 0.97.

4. Results

The performance of the manufacturing industry was first evaluated using selected ratio indicators for the period 2013 - 2022. The ratio analysis revealed that the development of the selected indicators changed significantly during the analyzed period. It is therefore very difficult to determine which year was the best and which year was the worst in terms of the performance of the manufacturing industry. Therefore, a multi-criteria decision-making method will be used for a comprehensive evaluation of performance development.

Since decision-making is carried out by a small group of decision-makers, it has a subjective character. The criteria used are quantitative in nature and will not be normalized.

Using the formula (13), the weights of the indicators are first determined. Indicators, criteria, are marked as C1-C7. Specifically, C1 is an indicator of ROE, C2 is the total indebtedness, C3 is the degree of coverage of fixed assets, C4 is the turnover period of receivables, C5 is the turnover period of payables, C6 is the current liquidity, and C7 is the quick liquidity.

The matrix consistency is verified using the formulas (14) and (15). The calculation of criteria weights and the verification of matrix consistency are shown in Table 4.

Table 4: Determination of criteria weights

	C1	**C6**	**C2**	**C7**	**C4**	**C5**	**C3**	**geomean.**	w_i	$w_i \,.\, A_i$	$(w_i \,.\, A_i)/w_i$
C1	1	2	3	4	6	6	8	3.5360	0.3543	2.5859	7.2981
C6	1/2	1	2	3	5	5	7	2.4468	0.2452	1.7631	7.1909
C2	1/3	1/2	1	2	4	4	6	1.6407	0.1644	1.1809	7.1830
C7	1/4	1/3	1/2	1	3	3	5	1.0940	0.1096	0.7922	7.2271
C4	1/6	1/5	1/4	1/3	1	1	3	0.5046	0.0506	0.3629	7.1764
C5	1/6	1/5	1/4	1/3	1	1	3	0.5046	0.0506	0.3629	7.1764
C3	1/8	1/7	1/6	1/5	1/3	1/3	1	0.2529	0.0253	0.1878	7.4069
∑								9.9796	1		7.2370

Source: own processing

If n=7 and RI=1.35, CI=0.0395 and CR=0.0293 were calculated. This fulfills the condition that CR must be lower than 0.1, and the matrix is therefore consistent.

After calculating the criteria weights, the level of the manufacturing industry of the Czech Republic and their development are analyzed and evaluated. First, a matrix of alternatives is constructed for each criterion. These are the values of indicators of individual years.

Among the selected criteria are maximization and minimization criteria. Criteria of a minimization nature are not converted to maximization, but the lowest value of the criterion is considered the best. The determined values and local priorities are shown in Table 5.

Subsequently, the utility values, i.e. the global priorities of the alternatives, are calculated. On their basis, it is possible to evaluate the manufacturing industry in the Czech Republic in the individual years of the analyzed period of 2013-2022, as well as its development. Formula (16) is used to calculate total utility values. The resulting values of the calculations are shown in Table 6.

Table 5: Evaluation of the manufacturing industry (local priorities)

	C1	C2	C3	C4	C5	C6	C7
2013	0.0349	0.0443	0.2686	0.0147	0.0159	0.0141	0.0526
2014	0.1934	0.0789	0.0686	0.0195	0.0688	0.0721	0.1554
2015	0.2721	0.1490	0.0477	0.0813	0.2551	0.1766	0.2295
2016	0.1291	0.1490	0.0221	0.0362	0.1765	0.2581	0.2295
2017	0.1291	0.0789	0.0323	0.0537	0.1100	0.1766	0.1554
2018	0.0540	0.1490	0.1321	0.1224	0.1100	0.0721	0.0526
2019	0.0349	0.1490	0.1902	0.2479	0.1100	0.0431	0.0345
2020	0.0146	0.0789	0.1902	0.0537	0.0159	0.0431	0.0526
2021	0.0839	0.0789	0.0323	0.1224	0.0278	0.0721	0.0241
2022	0.0540	0.0443	0.0159	0.2479	0.1100	0.0721	0.0139
∑	1	1	1	1	1	1	1

Source: own processing

Table 6: Evaluation of the manufacturing industry (global priorities)

	C1	C2	C3	C4	C5	C6	C7	P_j
w_i	0.3543	0.1644	0.0253	0.0506	0.0506	0.2452	0.1096	
2013	0.0349	0.0443	0.2686	0.0147	0.0159	0.0141	0.0526	0.0372
2014	0.1934	0.0789	0.0686	0.0195	0.0688	0.0721	0.1554	0.1224
2015	0.2721	0.1490	0.0477	0.0813	0.2551	0.1766	0.2295	0.2076
2016	0.1291	0.1490	0.0221	0.0362	0.1765	0.2581	0.2295	0.1700
2017	0.1291	0.0789	0.0323	0.0537	0.1100	0.1766	0.1554	0.1281
2018	0.0540	0.1490	0.1321	0.1224	0.1100	0.0721	0.0526	0.0822
2019	0.0349	0.1490	0.1902	0.2479	0.1100	0.0431	0.0345	0.0741
2020	0.0146	0.0789	0.1902	0.0537	0.0159	0.0431	0.0526	0.0428
2021	0.0839	0.0789	0.0323	0.1224	0.0278	0.0721	0.0241	0.0714
2022	0.0540	0.0443	0.0159	0.2479	0.1100	0.0721	0.0139	0.0641
∑	1	1	1	1	1	1	1	1

Source: own processing

From the values calculated above, the development of the performance of the manufacturing industry in the Czech Republic in the period 2013-2022 cannot be evaluated as positive. After three years of desirable development, there is a reduction in the level of the manufacturing industry. The best results were found in 2015, but since that year the situation has worsened and the level of the manufacturing industry in 2020 falls to the level of 2013.

5. Conclusions

The contribution aimed to analyze and evaluate the financial performance of the manufacturing industry in the Czech Republic in the years 2013-2022 using multi-criteria decision-making methods. Selected ratio indicators, ROE, total indebtedness, degree of coverage of fixed assets, receivables turnover period, payables turnover period, current liquidity, and quick liquidity were used for performance evaluation. Data for the calculation of selected ratio indicators were obtained from the website of the Ministry of Industry and Trade of the Czech Republic. Subsequently, the manufacturing industry was evaluated based on selected indicators using multicriteria analysis methods, specifically the AHP method.

By applying the AHP method, the preferences of the selected indicators were determined. The most significant indicator with the highest preference was the indicator of ROE with a weight of 0.3543. For the indicator of the current liquidity, a weight of 0.2452 was calculated, for the indicator of total indebtedness, a preference of 0.1644 was determined, and for the indicator of quick liquidity, a preference of 0.1096 was determined. The indicator of the turnover period of receivables and the indicator of the turnover period of payables with a weight of 0.0506 were determined as little important. The indicator of the degree of coverage of fixed assets with a weight of 0.0253 was determined as the least important.

Subsequently, the performance level of the manufacturing industry was evaluated in individual years and for the entire analyzed period. According to the calculated values, the manufacturing industry of the Czech Republic did not achieve the desired development in the analyzed period. In almost all years of the analyzed period, there was a decrease in the annual values of the calculated utility. Exceptions are the years 2014, 2015 and 2021, when the value of the calculated annual utility value is increasing. The best results were found in 2015, but since that year the situation has worsened and the level of the manufacturing industry in 2020 falls to the level of 2013.

The highest total utility value was reached in 2015. In this year, ROE, total indebtedness, and turnover period of payables achieved the best values for the entire analyzed period in the manufacturing industry. The selected liquidity ratios achieved the second-best value. On the contrary, the indicators of the turnover period of receivables and the degree of coverage of fixed assets average values.

By using the decomposition methods of multi-criteria decision-making, in this case, using the AHP method, it was possible to analyze the development in a way that analysis by ratio indicators cannot provide. The first reason is that when ratios are used, all indicators are viewed as equally important. In reality, however, this is not the case and the importance of individual indicators is different. The second reason is that evaluating multiple indicators simultaneously is problematic, if not impossible.

In conclusion, it is possible to state that the use of decomposition methods of multi-criteria decision-making is a suitable tool for evaluating the performance of a selected industry or company.

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Implementation of ESG Reporting in Czechia

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Abstract

Environmental, Social, and Governance (hereinafter ESG) reporting is a non-financial reporting. It offers a framework to communicate company's activities with its stakeholders such as customers, employees, investors, governments, regulators, and other stakeholders mainly in market-developed economies. As global awareness of sustainability and corporate responsibility grows, companies are increasingly expected to focus not only on their financial performance but also on their impact on the environment, society, and governance structures as well. Due to this fact, ESG reporting has become obligatory for specified companies in the European Union and the range of these companies will grow sharply within the next years. The main aim of this analytical paper is to describe the process of implementation of ESG reporting in Czechia based on the Czech legislation.

Key words

ESG Reporting, Processing of ESG Reports, Czechia, Environmental aspects, Social aspects, Governance aspects

JEL Classification: M14, M48, Q51, Q58

1. Introduction

Environmental, Social and Governance reporting (hereinafter ESG reporting) deals with a broad spectrum of issues such as environmental, social, and governance criteria. In the European Union, the ESG reporting is based on the European Sustainability Reporting Standards (hereinafter ESRS). These standards were adopted by the European Commission (Rabaya et al., 2021).

Their goal is to standardize the reporting of sustainability information by companies within the European Union, aligning with the Corporate Sustainability Reporting Directive (hereinafter CSRD) (Dathe et al., 2022). ESRS provide a clear and consistent framework for companies to disclose their environmental, social, and governance performance. They improve transparency, understandability, and comparability for investors and other stakeholders as well (Březinová, 2023).

Environmental criteria deal with the impact of the company on the environment. They examine aspects such as energy use, pollution, resource conservation, waste management, and

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other important environmental impacts (Falkenberg et al., 2023). Based on the social criteria, the companies must report their labour practices, information on how they follow human rights, and community engagement as well (Dathe et al., 2022). Hence, the companies must describe their relationships with customers, suppliers, their employees, and the communities where the companies operate (Nicoló et al., 2021). Finally, governance aspects deal with the company`s leadership, audit, internal controls, executive pays or shareholder rights.

Regarding risk management, the ESG reporting is very important because it provides a comprehensive view of non-financial risks that can significantly impact a company (Bullay, 2019). It assesses possible environmental risks, analyzes regulatory changes, highlights social risks including labor risk, corruption, reputational damage, protection against frauds etc. Therefore, the ESG reporting describes possible risks and on the other hand, it helps companies to identify and (how) to minimize risks and discover opportunities in the market to ensure higher financial soundness and performance.

Companies adopting the ESG principles can benefit from improved risk management, enhanced brand reputation, and stronger financial performance. In terms of risk management, the company can be able to identify and address potential environmental, social, or governance risks very early (Iamandi et al., 2019). Therefore, it can minimize its negative impact on its activities. This is not just only about compliance with legislation or standards, but it is a strategic decision to focus on all mentioned activities at all. It can drive significant benefits across various aspects of a business (An, 2023).

It is due to the fact, that customers can prefer companies that minimally cause negative environmental impacts, can communicate with their customers and fulfill their needs in terms of environmental or social issues, demonstrate a commitment to sustainability and ethical practices, build trust with customers to increase brand loyalty and customer retention as well (Faccia et al., 2021).

Subsequently, these companies are ready to attract and retain top talented employees who prioritize sustainability and social responsibility. Moreover, this situation can boost and lead to better employee morale, engagement and support a positive workplace culture as well.

Better access to external capital is other positive factor that should be taken into consideration. Banks and other investors can prefer sustainable companies because of the ESG practices and its reporting can lead to better credit ratings and it can potentially decrease the cost of external capital.

On the other hand, the ESG reporting is connected with many negative factors that must be considered by the company (De Lucia et al., 2020). Firstly, the companies must spend a lot of money on all activities related to the processing of ESG reports in the company (Al Amosh et al., 2023). Processing of all data, preparation of analyses, and finalizing of reports will lead to investments in new software products, company processes, or staff. Because the processing of ESG reports is not simple, there is a risk of the accuracy, and reliability of ESG data.

Moreover, companies may have problems with correct data collection and their subsequent processing. Probably, many activities related to the ESG reports processing will be outsourced and the risk should be seen in possible inaccurate or misleading data processing (Sichigea et al., 2020).

Hence, some of the data could be confidential and when it is disclosed, the competitors can benefit from this information. Therefore, the companies can hesitate to correctly and fully disclose all relevant information in their reports (Arvidsson and Dumay, 2021).

Finally, during first years of ESG reporting adoption, there could be problems with possible regulatory uncertainty and comparability, because the European Union consists of 27 member states that separately incorporate the EU directives into their national law.

2. European Sustainability Reporting Standards

The main aim of the European Sustainability Reporting Standards is to enhance and standardize the reporting of sustainability information by companies within the European Union. They provide a clear and consistent framework for companies to disclose their environmental, social, and governance performance. Subsequently, they improve the comparability and transparency of disclosed information for all stakeholders interested in this kind of reporting. These standards were adopted by the European Commission on 31st July, 2023. The current standards are split onto 4 main groups. The first group of standards deals with general requirements and disclosures. The second group deals with environmental issues. The third one focuses on social aspects, and finally, the fourth one deals with governance.

Table 1 presents the list of European Sustainability Reporting Standards related to the general requirements and disclosures as of 1st January, 2024.

Table 1: List of European Sustainability Reporting Standards based on general requirements and disclosures as of 1st January, 2024

Abbreviation	Title	The main aim of the standard
ESRS 1	General requirements	Sets the foundation for all ESRS standards, provides general principles and requirements.
ESRS 2	General disclosures	Guides companies on how to report their impacts, performance, risk in key sustainability areas.

Source: own elaboration based on the Directive 2013/34/EU

The cross-cutting standards (ESRS 1 and ESRS 2) set general requirements and disclosure processes in two standards. Based on ESRS 1, the crucial key aspects deal with standardization and comparability; double materiality; comprehensive coverage; mandatory reporting; and alignment with global standards.

Standardization and comparability aspect is one of the most important goals of the reporting in the EU. There is achieved comparability of sustainability information between different companies and sectors due to this aspect. Stakeholders will get information that is comparable and trustable.

Double materiality aspect represents situation when the companies report information how sustainability issues affected their financial performance, and subsequently, on how they impacted the environment and society. Based on this aspect, the company provides a more comprehensive understanding of a company`s impacts on sustainability.

Comprehensive coverage deals with different topics related to the ESG reporting such as climate change, biodiversity, resource use, social and employee matters, human rights, bribery, and anti-corruption issues.

Mandatory reporting is based on the duty to report sustainability issues by the company. The obligation to publish ESG reporting has started for banks, insurance companies, listed corporations, large public-interest companies since 2024. Subsequently, the wide range of companies will be affected by this obligation within next few years.

Based on ESRS 2, the companies got detailed guidelines on how to report non-financial information and ensure that sustainability reporting remains comparable, transparent, and consistent across different accounting entities.

Finally, the alignment with global standards will help to ensure consistency in ESG reporting globally.

Table 2 describes the list of ESRS focused environmental issues.

Table 2: List of European Sustainability Reporting Standards focused on environment as of 1st January, 2024

Abbreviation	Title	The main aim of the standard
ESRS E1	Climate change	Deals with climate change adaption, climate change mitigation, and energy.
ESRS E2	Pollution	Focuses on air pollution, water pollution, soil pollution, pollution of living organism and food resources. Hence it deals with substances of concern, substances with very high concern, and microplastics.
ESRS E3	Water and marine resources	Identifies impact on water and marine resources focused on water consumption, water withdrawals, water discharges, water discharges in the oceans, and extraction and use of marine resources.
ESRS E4	Biodiversity and ecosystems	Deals with direct impact drivers of biodiversity loss in terms of climate change, land-use change, direct exploration, invasive alien species, pollution, and others. Analyses the impact of the state of species, on the extent and condition of ecosystems, and impacts and dependencies on ecosystem services.
ESRS E5	Resource use and circular economy	Analyses issues related to circular economy regarding resource inflows and resource use, resource outflows related to products and provided services. Hence it deals with waste as well.

Source: own elaboration based on the Directive 2013/34/EU

The ESRS consist of 5 main standards (ESRS E1 to E5) focusing on different aspects of environmental sustainability. ESRS E1 addresses climate change, requiring companies to disclose greenhouse gas emissions, climate risks and opportunities, transition plans, and scenario analysis.

ESRS E2 focuses on pollution, mandating reporting on pollutant emissions, reduction initiatives, and regulatory compliance.

ESRS E3 deals with water and marine resources, requiring disclosures on water usage, water risk management, and impacts on marine ecosystems.

ESRS E4 emphasizes biodiversity and ecosystems, with companies needing to report on biodiversity impacts, conservation efforts, and biodiversity management plans.

ESRS E5 focuses on resource use and the circular economy, requiring reporting on resource consumption, waste management, and circular economy practices. These standards ensure comprehensive environmental sustainability reporting, enhancing transparency and promoting global sustainability goals.

Table 3 shows European Sustainability Standards in terms of social aspects.

Table 3: List of European Sustainability Reporting Standards focused on social aspects as of 1st January, 2024

Abbreviation	Title	The main aim of the standard
ESRS S1	Own workforce	Focused on working conditions such as secure employment, working time, adequate wages, social dialogue, work-life balance, health and safety, freedom or collective bargaining. Hence it deals with equal treatment and opportunities (training and skills development, gender equality, diversity, etc.), and other work-related rights such as child labour, forced labour, privacy or adequate housing.
ESRS S2	Workers in the value chain	Deals with working conditions (adequate wages, secure employment, working time, health and safety, etc.), equal treatment and opportunities for all (gender equality, diversity, training skills development), other work-related rights (child labour, forced labour, water and sanitation, privacy).
ESRS S3	Affected communities	Focuses on economic, social and cultural rights of communities like adequate housing, food, water and sanitation, security-related or land-related impacts. Rights of indigenous peoples (self-determination, cultural rights, free, prior and informed consent) is analyzed as well.
ESRS S4	Consumers and end-users	Focuses on the personal safety of consumers or end-users, their social inclusion or information related impacts. Generally, it deals with no discrimination, privacy, health and safety, access to products and services, and protection of kids.

Source: own elaboration based on the Directive 2013/34/EU

ESRSs mentioned in Table 3 focus on different aspects of social sustainability. ESRS S1 deals with the treatment and well-being of employees, requiring companies to disclose information on working conditions, diversity and inclusion, employee health and safety, training and development, and labour rights. ESRS S2 focuses on workers in the value chain, mandating reporting on the social impacts of business activities on supply chain workers, including issues related to fair wages, working hours, child labour, forced labour, and the implementation of ethical sourcing practices.

ESRS S3 deals with affected communities, requiring disclosures on the impact of business operations on local communities, including community engagement, social investment, human rights impacts, and grievance mechanisms as well. ESRS S4 focuses on consumers and end-users, the obligation of companies to report on product safety, data privacy, customer satisfaction, and responsible marketing practices are crucial for elaboration of the report in terms of social aspects too.

We can say that these standards ensure comprehensive social sustainability reporting, enhancing transparency and accountability while promoting equitable and ethical business practices that benefit employees, supply chain workers, local communities, and consumers.

ESG reporting based on ESRS standard related to the governance issues is presented in Table 4.

Table 4: List of European Sustainability Reporting Standard focused on governance as of 1st January, 2024

Abbreviation	Title	The main aim of the standard
ESRS G1	Business conduct	Focused on corporate culture, management of relationships with suppliers including payment practices, political engagement, and lobbying activities, protection of a whistleblower, and corruption and bribery (prevention, detection, detection training or incidents).

Source: own elaboration based on the Directive 2013/34/EU

Based on ESG reporting regarding governance, the companies must currently comply only with one standard. ESRS G1 is based on reporting all crucial information about the company`s activities from the view of the relationship with suppliers. Mainly, this is very important when the customer is dominant in the market.

Next topics deal with political and lobbying activities, that must be fully described and presented.

Whistleblower protection helps to protect employees or other individuals who report breaches of law, money laundering, financial activities, product safety etc. Because of this is very significant topic, the EU member countries implemented legislation that ensures to protect these persons against the company or other subjects when they announce the law breaches.

As it is obvious, the problems related to ESG reporting based on the ESRS are complex. Therefore, the affected companies must be prepared to correctly report all information required by these standards.

3. Implementation of the ESG Reporting in Czechia

Czechia is one of the European Union member countries. Therefore, Czechia had to implement all EU directives related to the ESG reporting in its national law. Based on the Act on Accounting, the sustainable reports must be prepared by all large, medium-sized, and small-sized companies whose securities are listed on the public stock market. Other companies must prepare their sustainable reports only if they exceed at least 2 of 3 criteria (turnover higher than 50,000,000 EUR; asset value higher than 25,000,000 EUR; more than 250 employees) as of the balance sheet date for two consecutive accounting periods.

From 2024, the ESG reporting is obligatory for banks, insurance companies, large companies with more than 500 employees if their securities are listed on public stock markets. These companies must prepare the sustainable reports as part of their annual reports and verified by statutory auditors.

Subsequently, the duty to publish sustainable reports is set for other companies that meet at least two of three mentioned conditions from the accounting period 2025 onwards.

Finally, all listed small and medium-sized companies must report sustainability reports from 2026. These companies are allowed not to include a sustainability report in their annual reports for the accounting period beginning before 1st January, 2028. On the other hand, they must briefly inform about such decision all users of accounting information via annual reports and express sound reasons leading to their decision.

It can be stated that although ESG reporting brings numerous benefits, it can be financially burdensome for many accounting entities, especially for small and medium-sized ones, which

will have to report their activities to relevant business partners. They will have to decide, if the processing of ESG reports will be ensured through external providers as a service or carried out with their own employees.

4. Conclusion

Adopting ESG principles ensures compliance with regulations in the European Union. In terms of risk management, companies that effectively manage ESG risks can benefit from different areas such as better credit ratings or reduce the cost of external capital.

On the other hand, ESG reporting represents significant costs associated with data processing important for processing of sustainability reports, the whole analysis, and elaboration of final reports.

Despite these negatives connected with ESG reporting, the strategic benefits of comprehensive ESG reporting will support the importance of the whole mandatory reporting process and will support based on making strategic decisions that drive sustainable business practices in long term period.

Based on our research, we found that several large accounting entities operating in the Czech Republic have already prepared ESG reports for the previous accounting period. The aim was to inform users about the environmental, social, and governance activities within their operation.

On the other hand, accounting entities might have only presented information they wanted to publish. Information, they did not wish to disclose might not have been published. However, since 1st January, 2024, this is no longer possible due to the European Sustainability Reporting Standards, which require the implicated accounting entities to disclose the required information in a predefined structure, including the method of calculating the relevant values that are part of their ESG reports.

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Restrictiveness of environmental policy in European Union countries and revenues from environmental taxes

Magdalena Jarczok-Guzy [1]

Abstract

The aim of the article is to present and assess the degree of restrictiveness of environmental policy in individual European Union countries. The restrictive nature of the policy was compared with the revenues from environmental taxes. Thanks to data on municipal waste and electronic waste, the environmental policies of Poland and the Czech Republic were particularly assessed. The following data from the OECD database were used to conduct the analysis in this study: total environmental tax revenues as % of GDP, environmental tax revenues in the field of chemical management, in the field of circular economy, in the field of air pollution, in the field of fossil fuels; recycled municipal waste collected in kg per capita, electronic waste collected in kg per capita in Poland and Czech Republic.

Key words

Tax revenues, European Union, european environmental policy.

JEL Classification: H71, F64, F65.

1. Introduction

The aim of the article is to present and assess the degree of restrictiveness of the environmental policies of European Union countries, with particular emphasis on Poland and the Czech Republic. The research hypothesis assumes that as environmental policy becomes more restrictive, revenues from environmental taxes increase. It was also assumed that with the increasing stringency of environmental policy, the recycling of collected municipal waste increase.

The work will attempt to assess changes in the environmental policy implemented by two neighboring countries, such as Poland and the Czech Republic. Over the years 2004-2020, changes in municipal waste recycling, electronic waste collection and environmental tax revenues were assessed. These countries were chosen to particular analyze because they are neighbours with similiar tax systems and joined to European Union in the same period.

The tax is the income of public budgets, where in the form of a mandatory and usually regularly recurring payment is deducted on a non-refundable basis from the nominal income of the entity according to the tax law. Generally speaking, taxes are mandatory, irreversible, and inequivalent. First, compulsory means that taxpayers with tax obligations must abide by the state`s tax laws. Main aim of taxation is creating sources to finance government expenditures, to redistribute incomes and wealth of individual subjects and to support certain activities. By this way the role of taxes can be identified in influencing of economic growth, in reducing inequality between rich and poor people, in reduction of poverty etc. (Lisztwanová & Ratmanová, 2020).

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The following data from the OECD database were used to conduct the analysis in this study: total environmental tax revenues as % of GDP, environmental tax revenues in the field of chemical management, environmental tax revenues in the field of circular economy, air pollution and fossil fuels, recycled municipal waste collected in kg per capita, electronic waste collected in kg per capita in Poland and Czech Republic. The analyzed period is 2004-2021 but data for some variables for 2021 were not accessible yet.

2. Environmental policy

Sustainable development (SD) is a global challenge, which requires a progressive transformation of economies. According to the most quoted definition of the World Commission on Environment and Development, SD is development that meets the needs of the present without compromising the ability of future generations to meet their own needs. SD is fundamental objective of the EU enshrined in its primary law, governing all the EU's policies and activities. The 2030 Agenda for Sustainable Development and its 17 Sustainable Development Goals (SDGs), adopted by the United Nations (UN) in September 2015, have given a new impetus to global efforts for achieving SD. The SDGs provide a recent policy framework worldwide for the issues that are crucial for the SD path, such as the framework towards ending all forms of poverty, fighting inequalities and tackling climate change (Drastichová, 2018).

The new general Union Environment Action Programme which is entitled „Living well, within the limits of our planet" and „Europe 2020" strategy play a key role in a Green European Integration. The main mission of this programme is „the EU has agreed to step up its efforts to protect our natural capital, stimulate resource-efficient, low-carbon growth and innovation, and safeguards people's health and wellbeing – while respecting the Earth's natural limits" (Grudziński & Sulich, 2018).

In the last five years, the European Commission has issued some essential documents, taking up many commendable policies with the primary aim to prevent the generation of waste while tackling the problem at its root and maximizing the recovery of raw materials and energy from waste. At the same time, these policies pose a daunting challenge for many EU Member States in implementing new environmental protection regulations There is no sustainable development without sustainable consumption and recycling. Waste management is crucial here to reduce the amounts of toxic materials which are dangerous for natural environment and for future generations so on. Effective waste management is a part of sustainable development conception (Jarczok-Guzy, 2023).

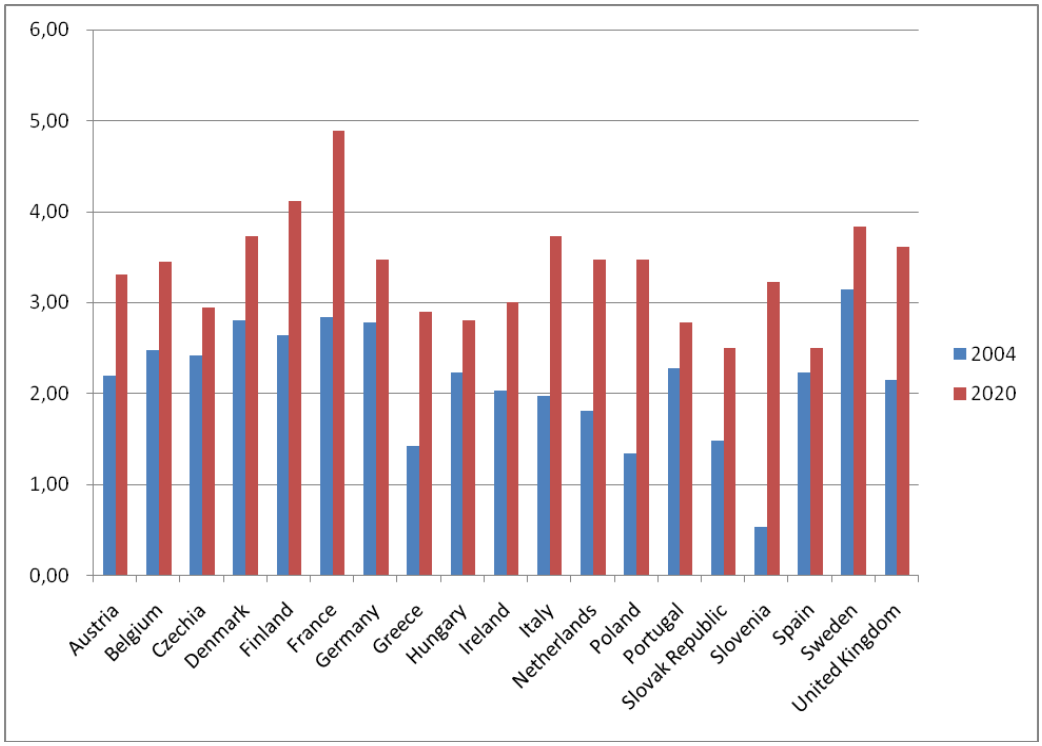

Figure 1: Environmental policy stringency in years 2004 and 2020 in EU

The restrictiveness of environmental policy in 2004 and 2020 in the European Union countries is illustrated in Chart 1. The first specific feature that can be noticed is a significant improvement in the restrictiveness index in the analyzed period, which should be assessed very positively in the light of the development and implementation of the concept of sustainable development. The observed increases in the indicator are very high. The data here were available only to 2020.

3. Data Analysis and results

In the next part of this work, the revenues from environmental taxes in the examined period will be analyzed as a % of GDP. Figure 2 shows tax revenues from environmental tax as % of GDP in total, while Figures 3a and 3b are divided into chemical management and circular economy and figures 3c and 3d into air pollution and fossil fuels. Data was not available for all countries (OECD database).

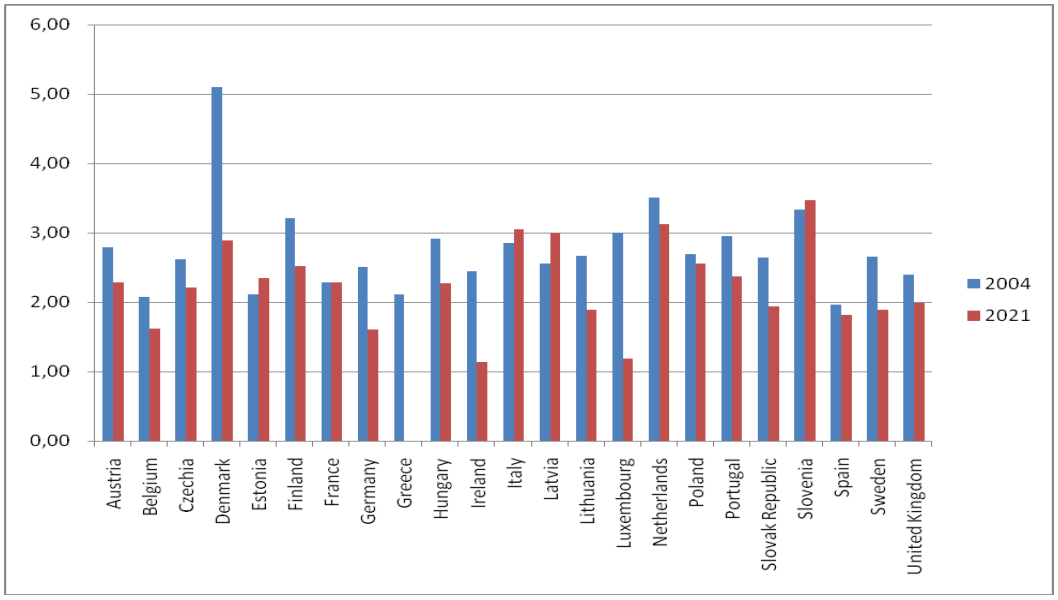

Figure 2: Tax revenues from environmental tax as % GDP in years 2004 and 2021 in EU

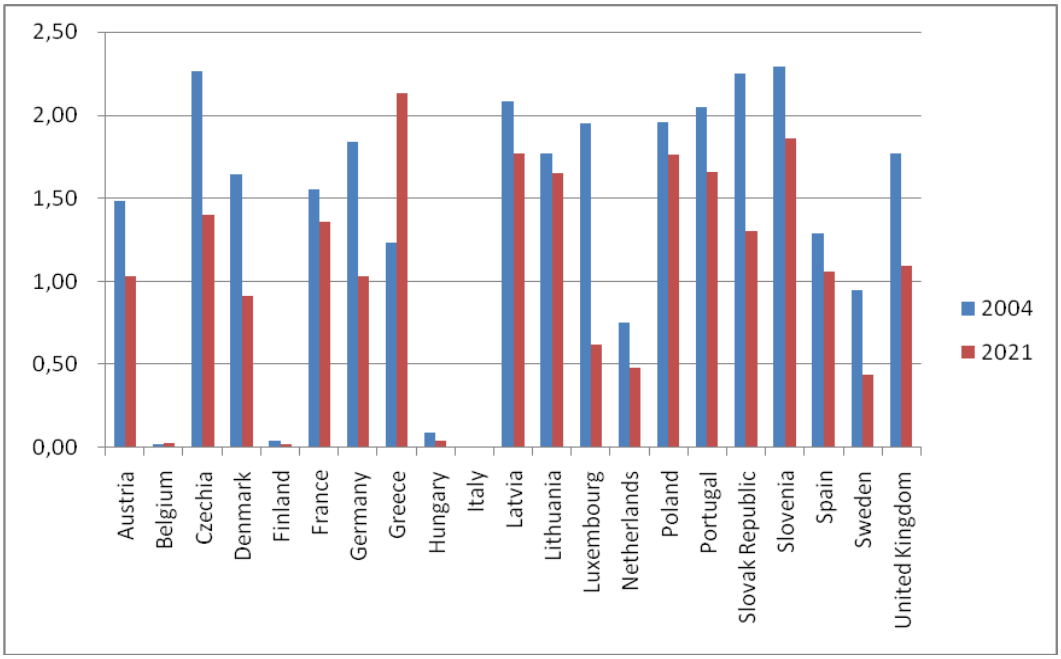

Figure 3a: Tax revenues from environmental tax as % GDP in 2004 and 2021 in EU chemical management

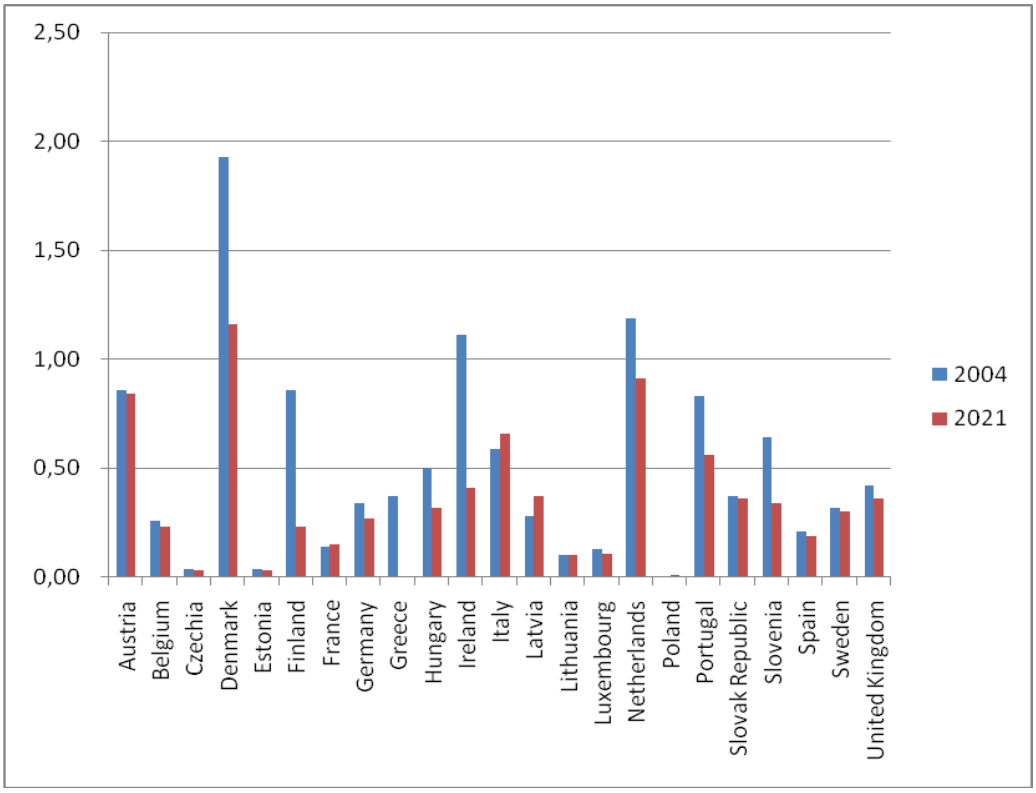

Figure 3b: Tax revenues from environmental tax as % GDP in 2004 and 2021 in EU circular economy

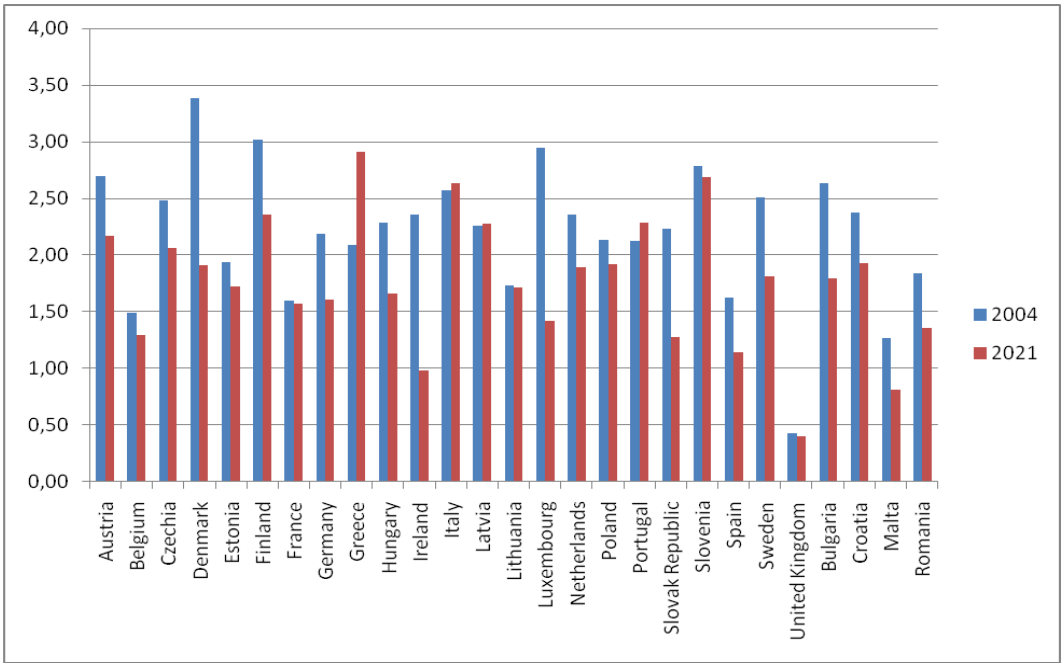

Figure 3c: Tax revenues from environmental tax as % GDP in 2004 and 2021 in EU air pollution

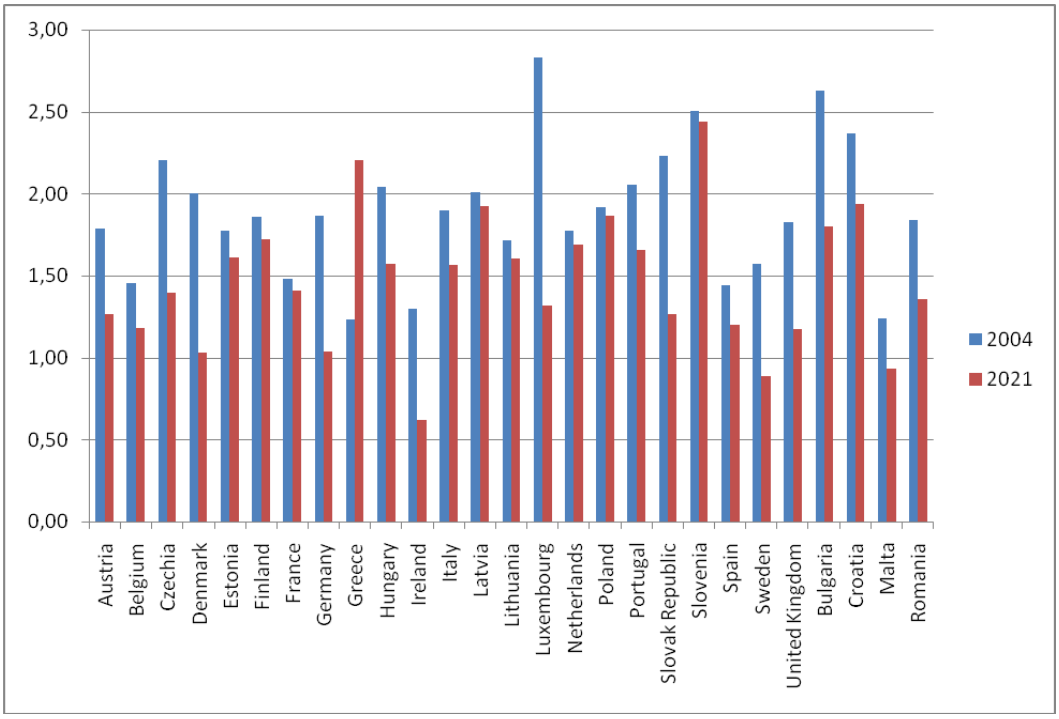

Figure 3d: Tax revenues from environmental tax as % GDP in 2004 and 2021 in EU fossil fuels

Total revenues from environmental taxes in the analyzed period vary depending on the European Union country. In most countries, a decline in the value of revenues was observed. However, in countries such as Estonia, Italy, Latvia and Slovenia, tax revenues from environmental tax as %GDP increased. The second stage of the analysis is to examine the impact indicator in the chemical management and circular economy category. In chemical management and circular economy, most countries experience a decrease in the variable. Countries with an increase in the variable are Belgium (from 0.02 to 0.03), France (0.14 to 0.15), Latvia (0.28 to 0.37). The next two types of field in environmental taxation are air pollution and fossil fuels. These are related with industry and were chosen to analyze. The rest of categories like radiation and water pollution have data only for some EU countries or the numbers were not significate. As we can see it on figure 3c tax revenues from environmental tax in category air pollution raised only in Greece (by 39%), Portugal (by 8%), Italy (by 2%) and Latvia (by 1%). In the rest of EU countries this indicator fell. However when we consider another category – fossil fuels we can observed that only for one country the level of analyzed indicator raised - in Greece (79%). In the rest of countries the number decreased with the most significant rate for Luxembourg 53%, Ireland 52%, Denmark 49%, Sweden 44% and Germany 44%.

Figure 4 shows the number of e-waste collected in kg per capita in Poland and Czech Republic in 2007 and 2020. Figure 5 shows municipal waste generated in kg per capita in European Union in 2004 and 2021. These two countries were chosen to particular analyze because they are neighbouring and became the European Union Members in the same time – 2004. It is interesting how they deal with protecting environment and waste managing from the beginning to current times.

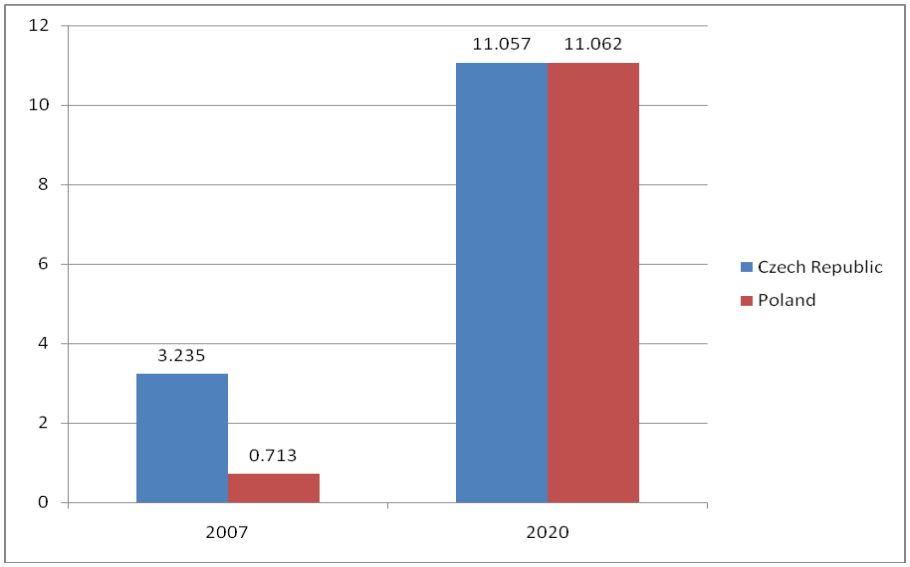

Figure 4: E-waste collected in kg per capita in Poland and Czech Republic in 2007 and 2020

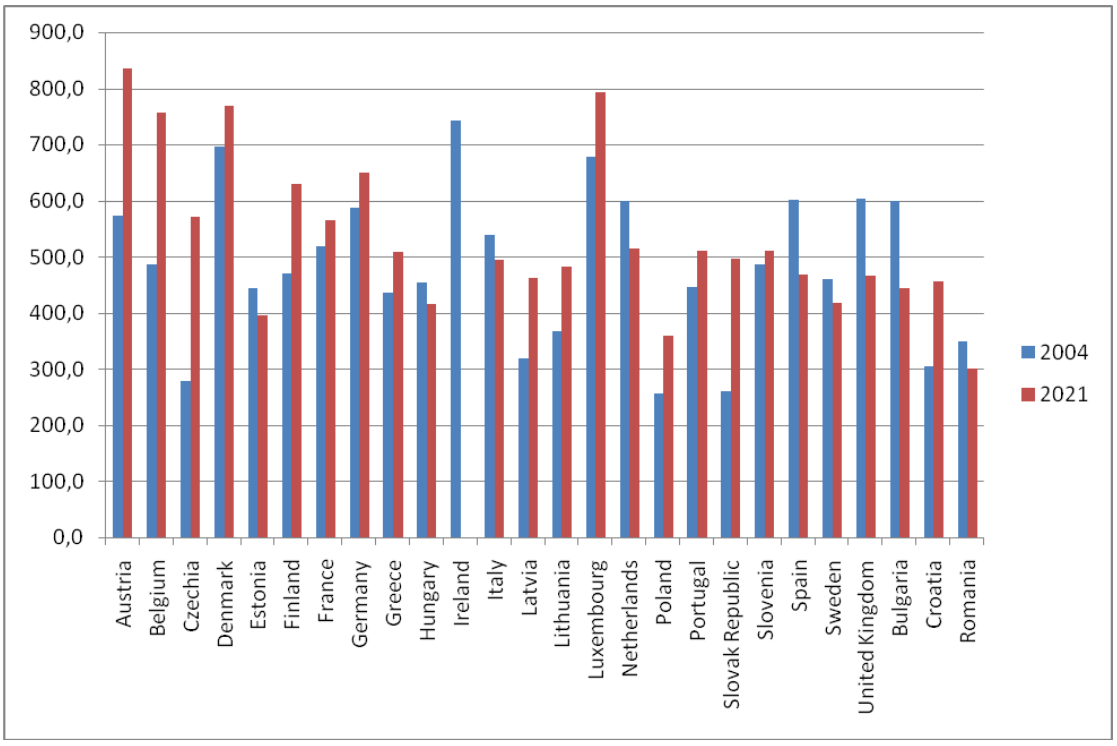

Figure 5: Recycled total waste generated in kg per capita in European Union in 2004 and 2021

Chart 4 shows the number of e-waste collected in kg per capita in Poland and Czech Republic in 2007 and 2020. In both analyzed countries, the number of e-waste collected in kg per capita increased. In Poland, this increase was spectacular - by as much as 10.349 kg. In the Czech Republic, there was also an increase, but by 7.822 kg. Taking into account the increased consumption of electronic equipment and the need for its recycling, this trend should be assessed positively.

Chart 5 shows recycled municipal waste generated in kg per capita in the European Union in 2004 and 2021. This is the number of collected wasted which were recycled. The data here are very different. In most countries, this indicator is increasing (16 countries), which should be accessed positively. However, there are countries where less municipal waste were collected and recycled, which may indicate poor environmental policy and illegal waste

storage. Such countries are: Estonia, Hungary, Italy, Netherlands, Spain, Sweden, United Kingdom and Romania.

The last stage of the study is the analysis of correlation indicators between the restrictiveness of environmental policy and selected variables. Table 1 shows that there is a strong or quite strong positive correlation in the case of data for Poland and the relationship between the restrictiveness of environmental policy and revenues from environmental taxes in the field of circular economy (0.690879991) and with recycled municipal waste generated in kg per capita (0.994506631). In the case of the Czech Republic, a positive correlation was also found for revenues from environmental taxes in the critical economy (0.685679764). However, one indicator was identified with a negative correlation with total environmental tax revenues for Poland (-0.79114606). These results shows strong correlation indicating the decreasing tax revenues with the tightening of restrictions. Analyzing the relationship between restrictiveness of environmental policy and revenues from environmental taxes in the field of air pollution there has been revealed strong correlation for Poland (-0.778522243) which means that with increasing restrictiveness of enviromental policy, tax revenues in the field of air pollution were decreasing.For the rest of European Union member countries this correlation rate was also negative but the strength of correlation was not so high. On the other hand the correlation between restrictiveness of environmental policy and revenues from enviromental taxes in the field of fossil fuels, there were observed negative rates in all cases. For Poland (-0.469362884) and Czech Republic (-0.465388388) the level of coefficients were similar and higher that in all European Union countries (-0.324680436).

Table 1: Correlation coefficients

	Correlation coeffiecients in EU countries	In Poland	In Chech Republic
Revenues from environmental taxes as a % of GDP and the restrictiveness of environmental policy	-0,019102402	**-0,79114606**	-0,307952775
Revenues from environmental taxes as a % of GDP in the field of chemical management and the restrictiveness of environmental policy	-0,280755978	-0,661222401	-0,509173551
Revenues from environmental taxes as a % of GDP in the field of circular economy and the restrictiveness of environmental policy	0,080311604	**0,690879991**	**0,685679764**
Revenues from environmental taxes as a % of GDP in the field of air pollution and the restrictiveness of environmental policy	-0,069888824	**-0,778522243**	-0,426179132
Revenues from environmental taxes as a % of GDP in the field of fossil fuels and the restrictiveness of environmental policy	-0,324680436	-0,469362884	-0,465388388
Recycled municipal waste generated in kg per capita and environmental policy stringency	0,326050213	**0,994506631**	0,414237413

4. Conclusion

The recycled municipal waste management policy in Poland and Czech Republic should be positively assessed. Compared to the European Union, in terms of the number of recycled municipal waste generated in kg per capita in 2021, the Czech Republic ranks 6th, while Poland ranks 19th. In Poland and the Czech Republic, a positive correlation is observed between the restrictiveness of environmental policy and revenues from environmental taxes as a % of GDP in the circular economy. Additionally, in Poland there was a very strong

relationship between restrictiveness and recycled municipal waste generated in kg per capita. This trend should be assessed very positively. It may prove the effectiveness of the adopted environmental policy. The spectacular increase in selective e-waste collection in both countries also deserves a positive assessment.

To conclude, the hypothesis formulated at the beginning of the work was fully confirmed for the both analyzed countries only in area of revenues from environmental taxes as a % of GDP in the field of circular economy and the restrictiveness of environmental policy.

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Evaluating Gold as an Investment: Perspectives on Long-Term and Short-Term Investing

Kateřina Kořená [1]

Abstract

Gold is widely acknowledged as a durable store of value, having preserved its purchasing power across centuries, in contrast to various currencies and other assets that may depreciate over time. Historically, gold has been perceived as a stable and secure investment option. This article aims to explore whether it is more advantageous to invest in gold for the long term or the short term, based on the analysis of its price fluctuations.

Key words

Gold, investing, price, investment instrument, long term, short term, histogram

JEL Classification: G5, G11

1. Introduction

Gold has long been revered globally for its intrinsic value and deep historical significance (O'Connor at al., 2015). Over time, it has maintained its status as a favored investment vehicle (Apanovych et al., 2023). For this reason, this article aims to analyze how returns and losses from investing in gold vary across different long-term investment horizons and whether it is more advantageous to invest in gold for the long term or the short term.

Gold is also esteemed as a "safe haven" (Baur and McDermott, 2010) during periods of geopolitical instability, economic crises, or financial market turmoil. When confidence in other financial assets wanes, investors turn to gold as a reliable store of value. Gold's universal recognition and acceptance across nearly every country further enhance its appeal as a secure investment option. According to Wang et al. (2011), investors purchase gold to hedge against any economic, political, or currency crises, for diversification as well as financial arbitrage purposes. Gold can be characterized as an emotional asset, too (Tyl, 2013) and historically and culturally, gold has been esteemed across various societies as a symbol of wealth, power, and purity, which imparts an intrinsic value that extends beyond its material worth (Schoenberger, 2010). Psychologically, gold provides a sense of security, especially during periods of economic uncertainty or geopolitical instability (Apanovych et al., 2023). For instance, during financial crises, the fear of losing wealth often prompts a rush to gold as a stable store of value, whereas periods of economic prosperity might see increased divestment from gold in favor of assets with potentially higher returns.

When evaluating gold purely as an investment instrument, it is crucial to recognize that it does not generate passive income in the form of dividends or interest (Tyl, 2013). Instead, gold provides the opportunity for capital appreciation over time (Šoja, 2019). Historically, investors who have purchased gold during periods of low market prices and subsequently sold it during periods of higher prices have often realized significant gains. Conversely, investors who have acquired gold at peak prices and sold during downturns have experienced losses.

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Therefore, the author aims to determine whether long-term or short-term investment in gold is more advantageous, based on a comprehensive analysis of its price fluctuations.

2. Determining the price of gold

The price of gold is established through a combination of various factors that encompass supply and demand dynamics, market trading activities, and broader economic conditions. On the supply side, gold is sourced primarily from mining production, recycled gold, and central bank reserves2. Changes in supply, though typically gradual, can influence prices, especially with significant shifts in mining output or government sales. Demand for gold comes from two principal areas - main components of demand for gold have been identified in the literature - namely the use and the asset demand (Levin and Wright, 2006). The use demand for gold pertains to its direct application in the production of jewelry, coins, electrical components, medals, and other such items. This type of demand is primarily influenced by the business cycle, particularly the purchasing power of firms and households. Conversely, the asset demand for gold underscores its role as an investment tool utilized by individuals, governments, and fund managers to hedge against inflation, economic recession, and other forms of uncertainty (Aye et al., 2016).

According Batten at al. (2008) the price of gold is necessary to assess individually to other precious metals because precious metals are too distinct to be considered a single asset class, or represented by a single index. Market trading plays a crucial role in determining gold prices. The spot price, which reflects the current price for immediate delivery, is influenced by over-the-counter (OTC) market trades. Additionally, gold futures contracts traded on exchanges like the COMEX set expectations for future prices and can affect the spot price through market arbitrage opportunities (Abken, 1980).

Central banks also impact gold prices through their buying or selling activities and monetary policies (Polášková et al., 2019). Policies such as interest rate adjustments and quantitative easing can indirectly influence gold prices by affecting currency values and inflation expectations. Given that gold is priced in U.S. dollars, fluctuations in the dollar's value have a direct impact on its price. A weaker dollar generally makes gold cheaper in other currencies, thus boosting demand and increasing its price.

Inflation and interest rates are other significant factors. Gold is traditionally seen as a hedge against inflation; when inflation rises, real returns on other investments decline, making gold more attractive. Conversely, higher interest rates increase the opportunity cost of holding gold, which can depress its price. Geopolitical and economic uncertainties also drive-up gold demand, as investors seek a safe haven during periods of crisis or instability, thereby pushing up prices (Shafiee and Topal, 2010).

Investor sentiment and speculation are pivotal in the short-term movements of gold prices. Traders' perceptions of future economic conditions, inflation, and risk can cause significant price fluctuations. Moreover, while less common, market manipulation and regulatory influences can affect gold trading and pricing.

2.1 Recapitulation

The price of gold is influenced by a combination of supply and demand factors, market trading activities, and broader economic conditions. Supply comes from sources such as mining and recycled gold, as well as sales from central bank reserves. Demand is driven by uses in jewelry, industrial applications, and as an investment vehicle. The spot price of gold is established through over-the-counter (OTC) market trading, with futures contracts on

[2] See https://www.gold.org/goldhub/data/gold-demand-by-country

exchanges like the COMEX influencing expectations and providing opportunities for arbitrage. Central banks impact gold prices through their purchases or sales of gold and through their monetary policies, which affect inflation and currency values. Since gold is priced in U.S. dollars, changes in the dollar's value directly influence its price, with a weaker dollar generally increasing demand for gold. As a traditional hedge against inflation, gold tends to rise in value when the purchasing power of currencies declines. It is also seen as a "safe haven" during periods of economic or geopolitical instability, which drives up demand during crises.

Short-term price movements are significantly influenced by investor sentiment and speculative trading, which are driven by perceptions of future economic conditions. Regulatory changes and occasional market manipulation can affect how gold is traded and priced. Additionally, the London Bullion Market Association's (LBMA) "London Fix" sets a daily benchmark price, reflecting the balance of supply and demand.

3. Methodology and data

This study examines gold as an investment instrument over a long-term horizon, using data from the period between 1971, the end of the Gold Standard (Craig, 2011), and June 2024. This 53-year timeframe captures the evolution of gold prices in a post-Gold Standard economy, allowing for a comprehensive assessment of its performance as an asset. The price data, sourced from the website "Auronum", are measured in U.S. dollars per ounce of gold, reflecting the global standard for gold valuation.

Figure 1: Price of gold 1971–2024 (dollar per ounce)

Source: https://auronum.co.uk/gold-price-news/historic-gold-price-data/, author

This historical period is divided into discrete intervals of varying durations -1 year, 2 years, 3 years, 5 years, 10 years, 20 years, and 30 years - allowing us to analyze the investment returns for different time horizons. The methodology assesses performance in terms of gains or losses across these intervals, which are visualized through histograms. The histograms categorize the results into distinct ranges: from losses exceeding 20% to profits exceeding

30%, with each range representing a 5% increment. This visual representation provides a nuanced picture of the profitability of investing in gold for each time horizon. Specifically, in Figures 2-8, the horizontal axis is segmented into 12 parts, each representing a 5% performance range, while the vertical axis indicates the frequency of specific outcomes-either positive or negative-over the entire dataset. This helps to assess how often a given level of profit or loss occurred within the specified time periods.

To calculate the returns for each time period, we employ the Compound Annual Growth Rate (CAGR) formula, which measures the annualized rate of return, accounting for the effects of compounding. The formula is as follows:

$$\mathrm{CAGR} = \left(\frac{V_f}{V_i}\right)^{\frac{1}{n}} - 1 \tag{1}$$

where:
Vf = the final value of the investment
Vi = the initial value of the investment
n = the number of years

CAGR is a reliable metric that accounts for the varying durations of the selected intervals, providing a consistent basis for comparing gold's performance over different time frames.

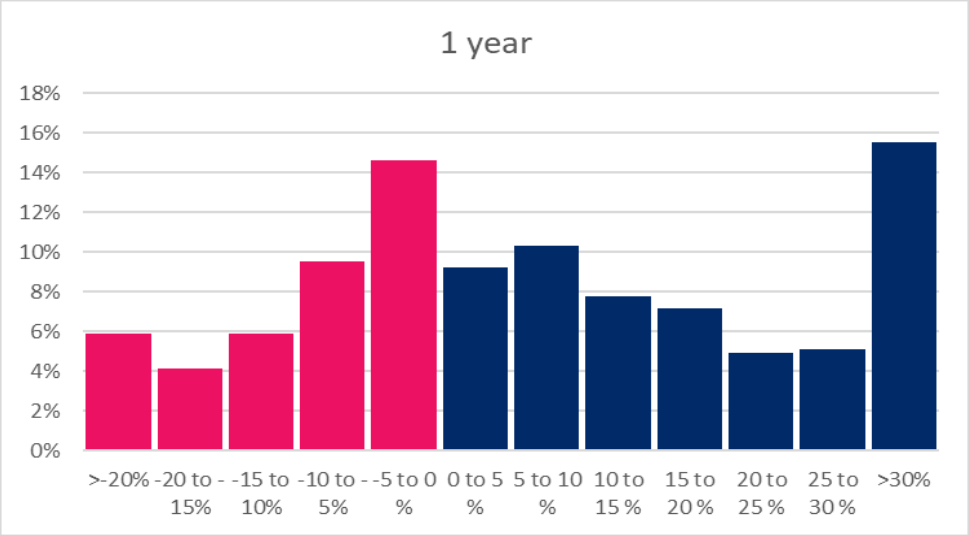
To enhance the analysis, moving averages are also employed to smooth out short-term fluctuations and highlight longer-term trends in gold price movements. These moving averages are calculated for each time interval (1 year, 2 years, 3 years, 5 years, 10 years, 20 years, and 30 years), with prices measured at the beginning of each month from January 1, 1971, to June 1, 2024. Using U.S. dollars as the reference currency is justified by its dominant role in global gold pricing, ensuring consistency and comparability of results.

Table 1 (see 4.1 Explanation) presents a detailed summary of the calculated results, offering insights into key performance indicators such as minimum, maximum, median, and average returns for each period. This table facilitates a deeper understanding of the volatility and returns associated with gold as an investment asset, both in the short and long term. Through this rigorous methodological framework, we aim to provide a comprehensive analysis of the advantages and limitations of investing in gold over various time horizons.

4. Results of investment performance

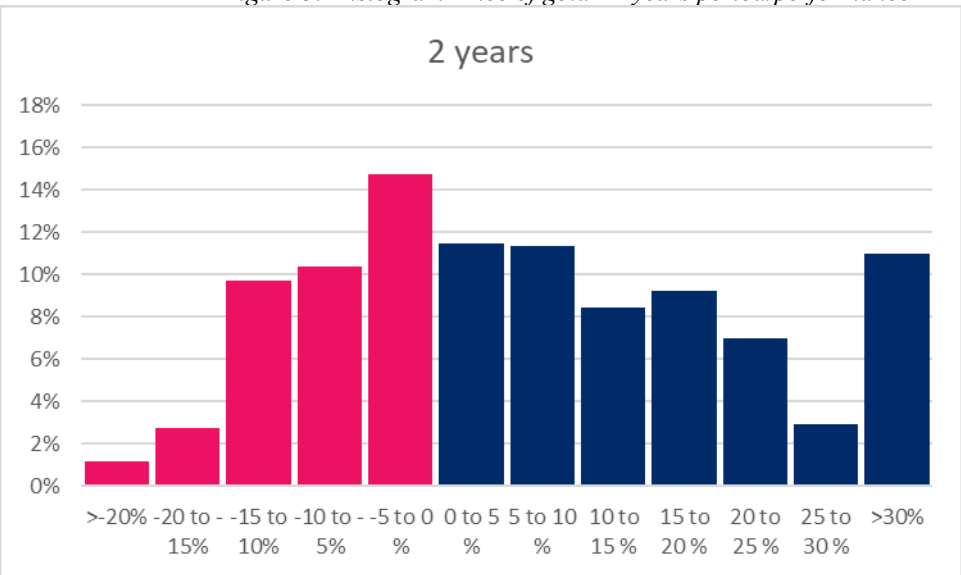
Gold prices are calculated from January 1, 1971, to June 1, 2024, at the beginning of each month. To systematically analyze the investment performance over different time horizons, the results were divided into two main categories: short-term and long-term investing. The short-term category encompasses investment horizons of 1, 2, 3, and 5 years, whereas the long-term category includes horizons of 10, 20, and 30 years.

Figure 2: Histogram Price of gold - 1 year period/performance



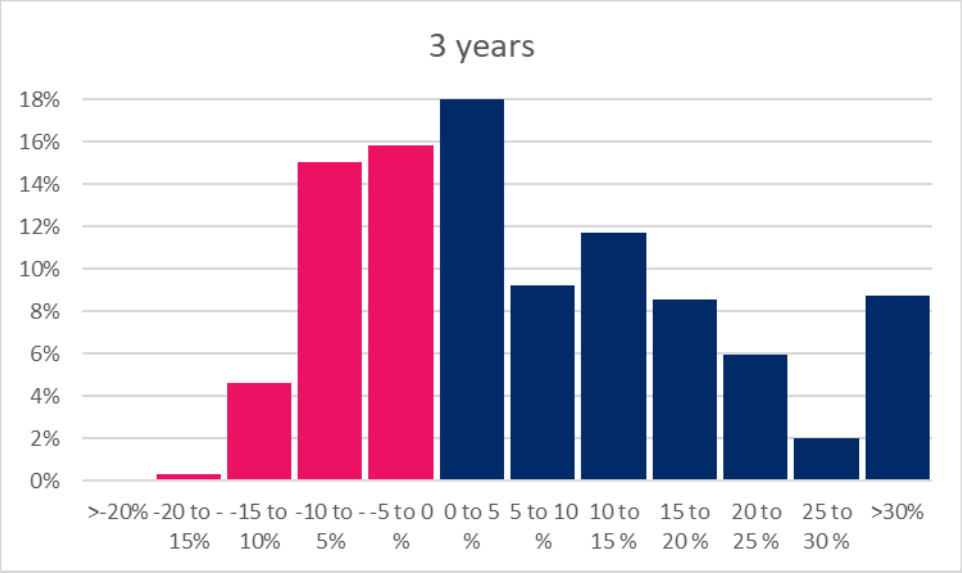
One-year yields are computed as the moving changes in gold prices over 12 months according to Formula 1. The total number of data points is 630. For the 1-year investment horizon (Figure 2), the most frequent outcomes were either a profit exceeding 30% or a modest loss of up to 5%, suggesting a seemingly favorable short-term outlook. However, it is crucial to note that approximately 40% of the observed outcomes resulted in a loss.

Figure 3: Histogram Price of gold - 2 years period/performance



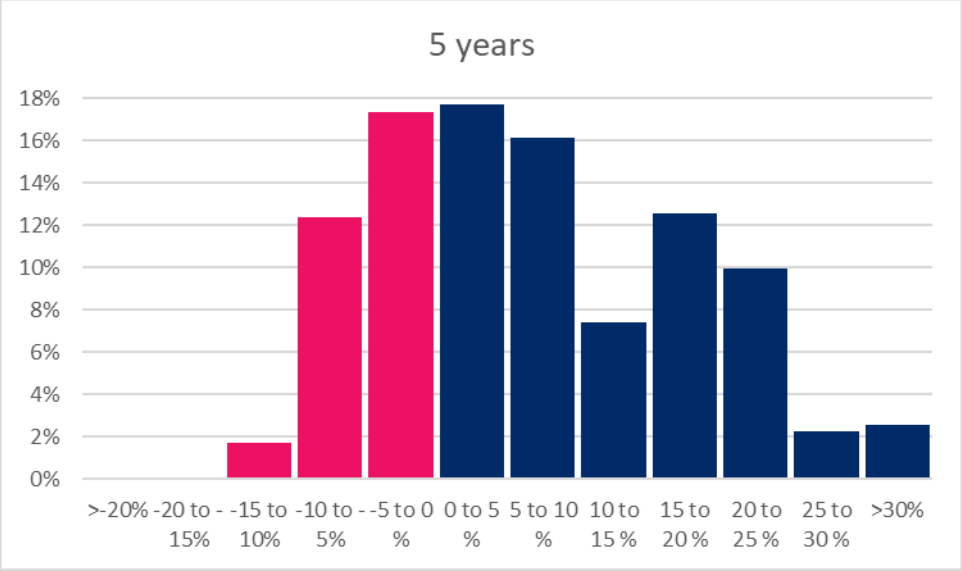
Two-year returns are calculated as the moving changes in gold prices over 24 months according to Formula 1. The total number of data points is 618. The 2-year investment horizon (Figure 3) displayed a similar overall pattern to the 1-year horizon, albeit with a reduction in the magnitude of losses.

Figure 4: Histogram Price of gold - 3 years period/performance



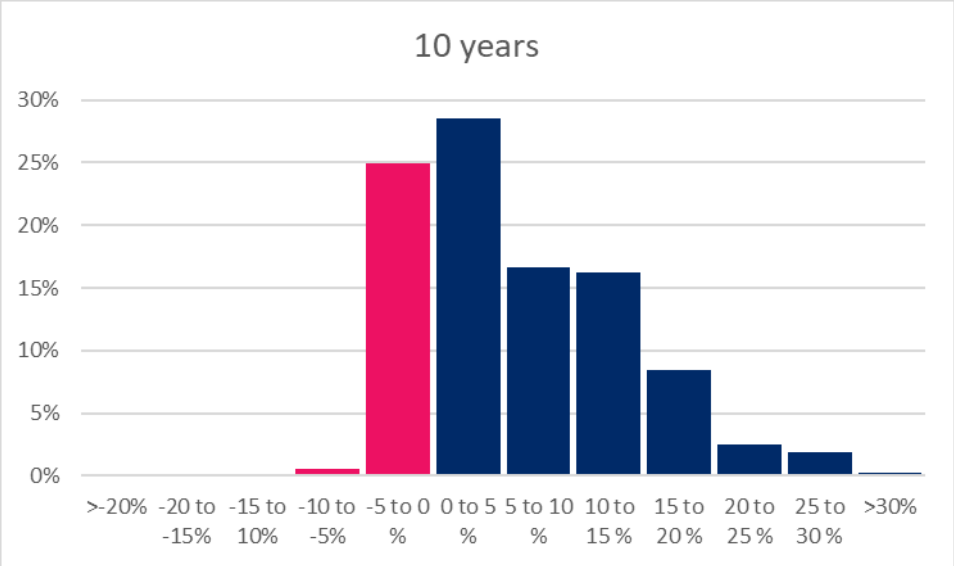
Three-year yields are computed as the moving changes in gold prices over 36 months according to Formula 1. The total number of data points is 606. In the case of a 3-year investment horizon (Figure 4), the results varied more significantly, with the most common outcome being a profit of up to 5%, closely followed by losses of up to 5% and up to 10%.

Figure 5: Histogram Price of gold - 5 years period/performance



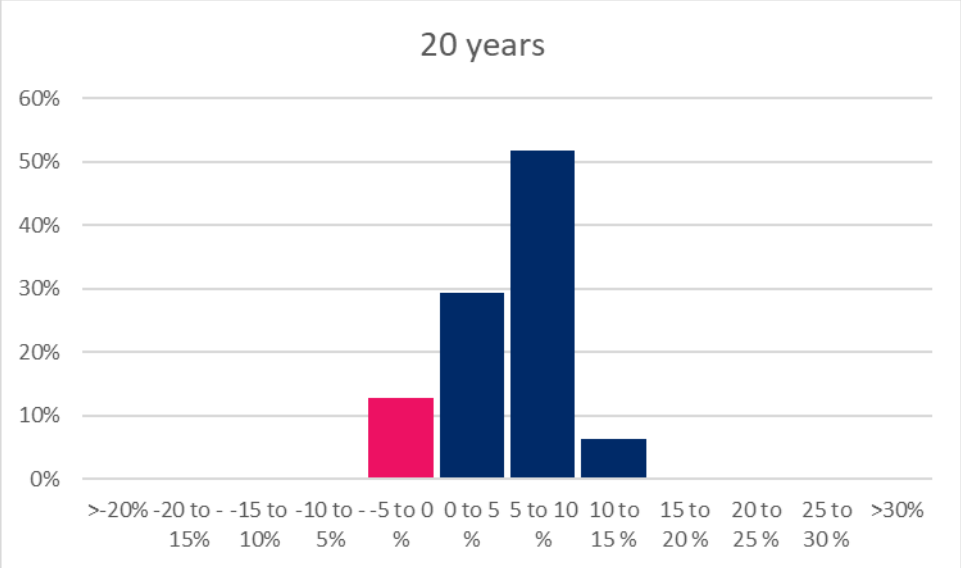
Five-year yields are computed as the moving changes in gold prices over 60 months according to Formula 1. The total number of data points is 582. For the 5-year horizon (Figure 5), the overall results indicated a shift towards profitability, with 69% of the outcomes yielding a profit and 31% a loss. The most common result was a profit of up to 5%, followed by a loss of up to 5%, while profits between 5% and 10% and losses between 5% and 10% were also prevalent.

Figure 6: Histogram Price of gold - 10 years period/performance



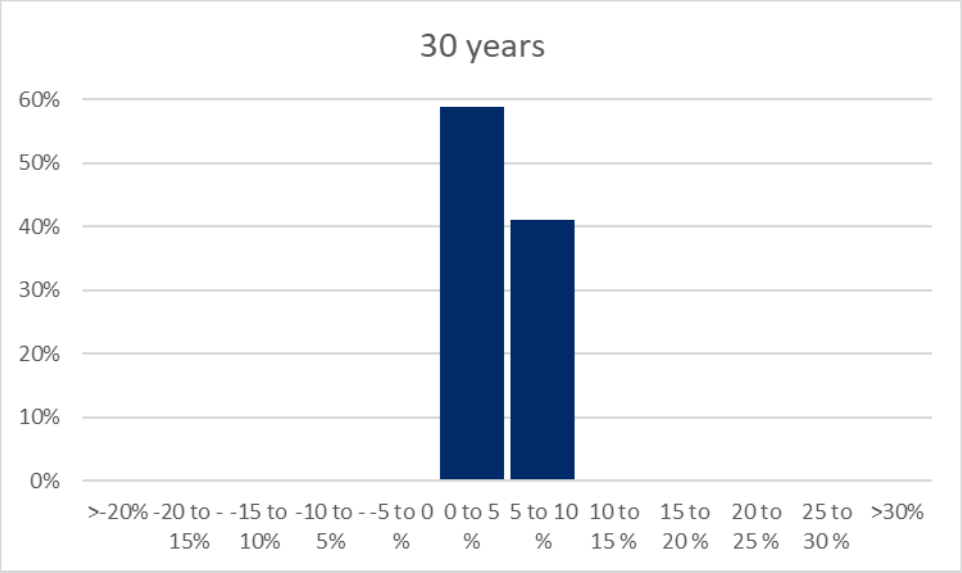
Ten-year yields are computed as the moving changes in gold prices over 120 months according to Formula 1. The total number of data points is 522. In the long-term category, the outcomes for the 10-year horizon (Figure 6) were notably more favorable, with 75% of the periods resulting in a gain and 25% in a loss. The most frequent results were a gain of up to 5% and a loss of up to 5%, followed by gains between 5% and 10%, and gains between 10% and 15%. This period showed that the occurrence of significant losses was limited, mainly confined to the 5% to 10% interval, while gains above 20% were infrequent.

Figure 7: Histogram Price of gold - 20 years period/performance



Twenty-year yields are computed as the moving changes in gold prices over 240 months according to Formula 1. The total number of data points is 402. For the 20-year horizon (Figure 7), the results were overwhelmingly positive, with an 87% profit rate and only 13% of the periods experiencing a loss, which was restricted to up to 5%. The most common profit range was between 5% and 10%, constituting over 50% of the outcomes, followed by profits of up to 5% at nearly 30%. Notably, profits did not exceed 15% in this time frame.

Figure 8: Histogram Price of gold - 30 years period/performance



Thirty-year yields are computed as the moving changes in gold prices over 360 months according to Formula 1. The total number of data points is 282. Finally, for the 30-year horizon (Figure 8), the results were unequivocally favorable. Throughout the observed period (1971–2024), there were no instances of breaking even or incurring a loss when investing in gold. The results demonstrated that the potential for significantly above-average gains was diminished over this horizon, with nearly 60% of the outcomes showing a profit of up to 5% and over 40% yielding a profit between 5% and 10%.

4.1 Explanation

If we summarize the results of the histograms and calculations (Table 1), it is possible to state that the development of the price of gold differs significantly in the short and long term. This is especially noticeable when investing for 1 or 2 years. If we invested in gold for 1 year in the period from 1971 to 2024, our average annual return was 10.5%, the minimum achieved was - 36.6% and the maximum 194.6%. The median was 5.6, so it is possible to say that in this case the distribution of values in the data set was asymmetric and pulled towards higher values, which means that the distribution is so-called "right-skewed". Similar results are also obtained in the case of investments for 2 and 3 years, but in both cases the maximum is lower than for 1 year, and for investments for 3 years the minimum is significantly lower. When investing for more than 5 years, the average and median approach each other, in the case of a 20-year time horizon, the median is even slightly higher than the average.

Table 1: Returns of gold price – minimum, maximum, median and average

Ø profit/years	1	2	3	5	10	20	30
minimum	-36,6%	-31,4%	-15,9%	-14,8%	-6,0%	-4,5%	1,7%
10%	-14,9%	-11,5%	-7,9%	-5,7%	-3,0%	-0,8%	3,3%
20%	-7,8%	-6,8%	-4,9%	-2,9%	-0,9%	1,6%	3,7%
30%	-3,3%	-2,9%	-1,7%	-0,3%	0,6%	3,0%	4,0%
40%	0,1%	0,7%	1,5%	1,5%	1,9%	4,6%	4,4%
median	5,6%	4,8%	3,6%	5,2%	4,0%	5,8%	4,6%
average	**10,5%**	**9,1%**	**8,2%**	**6,9%**	**5,8%**	**5,0%**	**4,6%**
60%	10,4%	9,3%	8,3%	8,3%	6,5%	6,4%	5,1%
70%	16,6%	15,2%	13,5%	12,7%	9,8%	7,6%	5,4%
80%	25,7%	20,5%	18,2%	18,5%	12,3%	8,5%	5,6%
90%	38,2%	31,7%	26,9%	22,0%	17,0%	9,5%	5,9%
maximum	194,6%	95,8%	72,0%	36,5%	31,6%	12,4%	6,8%

Finally, the behavior of gold prices exhibits notable distinctions across short and long-term investment periods. Over shorter horizons, gold prices have demonstrated considerable volatility, occasionally yielding exceptionally high returns. For instance, the average annual return over a 1-year period was 10.5%, with the maximum reaching 194.6%. Over a 2-year horizon, the average return was 9.1%, with a maximum return of 95.8%. This pattern gradually shifts as the investment horizon extends to 5 years, where the average annual return declines to 6.6% and the maximum return reduces to 36.5%. During this period, however, there remained a possibility of a cumulative loss of 31%. With longer investment horizons, there is a further reduction in average annual returns, amounting to 5% over 20 years and 4.6% over 30 years. Notably, in the case of a 30-year horizon, minimal disparity is observed between the median, average, and maximum returns.

5. Conclusion

This article is focused in more detail on the price of gold and yield, because the author wants to find out in a relatively simple and, above all, understandable way, whether and how investing in the short and long term differs from each other. Of course, it is necessary to add that the yield is only one part of the overall picture of results (risk, volatility, diversification, correlation with other assets, etc.) that can be ascertained and considered if we are interested in investing in gold.

Overall, the gold market is influenced by a complex interplay of factors that drive demand and supply. All these factors collectively determine the price of gold, balancing long-term stability with short-term market dynamics. Understanding these dynamics can provide valuable insights into how gold prices are likely to move in response to economic, geopolitical, and market developments. Based on these findings, it is possible to say that it is very difficult to determine the price of gold in the future, because predicting all these possible factors is almost impossible. And whether gold is still a guarantee of safe investment, it needs more time and data, because it is increasingly held as a financial instrument for speculative investment (O'Connor et al., 2015). Nevertheless, it is advisable to look at what the price of gold was in the past, and to at least get an idea of whether gold is more suitable for long-term or short-term investment.

Based on the previous findings, investing in gold can be recommended under specific conditions for both short and long-term horizons. For short-term investments (1-2 years), individuals with a high-risk tolerance who can navigate volatility may find gold appealing,

given its potential for high returns demonstrated by maximum gains exceeding 90% over two years. Market timing, where investors capitalize on price fluctuations, can also play a crucial role. Conversely, long-term horizons (5 years or more) make gold an attractive option for portfolio diversification. While average annual returns diminish over extended periods (e.g., approximately 5% over 20 years), they still provide steady, moderate growth potential. Both short and long-term gold investments require careful consideration of individual risk tolerance, investment objectives, and market conditions. Monitoring global economic trends and geopolitical developments can aid in making informed decisions tailored to one's financial goals ((Shafiee and Topal, 2010).

In summary, while short-term investments in gold may offer potential for high returns amid volatility, long-term investments are often favored for diversification (Šoja, 2019) and wealth preservation purposes (O'Connor et al., 2015). And it is necessary to add according Syrový and Tyl (2020), that each investor's financial goals and risk tolerance should guide their decision regarding the appropriate investment horizon for gold.

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Impact of Investor Sentiment on Stock Characteristics in Big vs. Small Companies

Bahate Maidiya[1], Aleš Kresta[2]

Abstract

This study examines the impact of investor sentiment on stock market characteristics using daily data from 841 large companies in the Russell 1000 index and 1,235 small companies in the Russell 2000 index from January 1, 2000, to December 31, 2023. We compare returns, Fama-French five-factor model factors, volatility, and trading volumes between large and small firms. Our findings show that sentiment affects large and small companies differently. Sentiment has limited explanatory power for returns and premiums but affects small firms more in market factors (e.g., SMB, HML, CMA). Sentiment negatively impacts volatility, more so for small firms. Additionally, sentiment's effect on trading volume is more significant for large firms. These results indicate investor sentiment influences market behavior differently based on firm size, emphasizing the importance of sentiment management in investment strategies.

Key words

Behavior finance, Investor sentiment, Finance.

JEL Classification: G12, G14, G41

1. Introduction

The Efficient Market Hypothesis (EMH) has benefits and drawbacks. It provides a framework for evaluating prediction accuracy and can lead to information-efficient markets (Granger, 2002; Kuan, 2009). However, it is criticized for ignoring investor behavior, leading to market inefficiencies and opportunities (Bollinger, 2005). Behavioral finance challenges EMH by highlighting irrational market participant behavior, resulting in inefficiencies and anomalies due to cognitive and emotional biases (Kartašova, 2014; Bowman, 1995). Behavioral finance, focusing on human weaknesses and cognitive biases, offers a more realistic approach than EMH (Barone, 2003). These biases impact returns and can lead to self-defeating behaviors and costs for investors (Singh, 2012). Investor sentiment impacts investment behavior through factors like overconfidence and herd behavior (Nareswari, 2021). Individual sentiment and cognitive biases influence market trends (Zhou, 2023), with market and herd effects playing key roles (P.H. 2019). Sentiment impacts stock market returns (Corredor, 2013), market activities (Muhammad, 2021), and trading volume, showing a positive correlation with VIX (Lei, 2012; So, 2015; Lai, 2014). It affects volatility, with irrational sentiment increasing it during bullish and bearish periods (Hu, 2010; Jiang, 2020). Sentiment influences small-cap stocks more than large-cap stocks (Li, 2017; Yong, 2015; Kumar, 2003). Sentiment indices can be derived from market factors, media information, or investor surveys (González-Sánchez & Morales de Vega, 2021).

While previous studies have explored the impact of investor sentiment on stock returns and volatility, this paper uniquely examines the differential impact of sentiment on large and small

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firms using a comprehensive dataset of the Russell Index over a 23-year period. This approach allows for a more nuanced understanding of how sentiment affects companies of different sizes.

This study examines the relationship between individual investor sentiment and stock market characteristics, including returns, volatility, and trading volume, comparing the influence on large companies in the Russell 1000 and small companies in the Russell 2000. We assess the impact of sentiment by integrating the sentiment index with components of the Fama-French 5-factor model (Fama & French, 2015). Our findings highlight the significance of individual investor sentiment in financial markets and its effect on investment strategies. Unlike traditional studies focused on market indices, our comprehensive dataset includes all constituent companies of the Russell 1000 and Russell 2000 indices, providing a deeper understanding of market behavior and risk-return relationships. We find a negative correlation between sentiment and both volatility and trading volume, offering valuable insights for investors and policymakers.

The structure of this study is as follows: in the next section, we present the data and methods used in this paper. In the third section, we provide results and make comparisons. The final section succinctly summarizes the main findings from our investigation and concludes with them.

2. Data and methodology

In this section, we present the data and methodology of the study.

2.1 Data

All our data comes from publicly available web data. It is very fortunate because the amount of data for our study is large. It would be very difficult to do by downloading the data manually and traditional analysis tools. Therefore, our research was done with the help of Python and we were able to achieve the purpose of this research.

2.1.1 AAII sentiment

The AAII Sentiment Index is an indicator surveyed and developed by the American Association of Individual Investors (AAII). The index is released every Thursday at U.S. time. The survey is distributed by asking AAII member investors whether they think the stock market will move up (bearish), flat, or down (bearish) in the next six months. This survey has been in existence since 1987 and was originally conducted via postcard mailings, but is now voted on via the Internet. In addition, the AAII now has over 160,000 members, the majority of whom are highly educated and demonstrate a certain level of investment knowledge. Therefore, this data is unique and can be quite informative in its ability to initially quantify investors' expectations for the future in several areas, conveying the attitude of a proactive individual investor. The Sentiment Index (AAII Sentiment Index) is calculated as the difference between the percentage of call and put votes. Since there are three metrics used to describe investor sentiment in the data provided by the AAII, we use the difference between the percentage of bullish and bearish votes to cover as much sentiment information as possible, with results ranging from -100% to 100%.

2.1.2 Russel 1000 and Russel 2000

In the United States, the top 3,000 stocks (shares of the 3,000 largest companies) make up the Broad Market Russell 3000 Index. It represents 98% of the investable stock market in the United States. This is because, in June of each year, Russell rebalances its index, known as a ‘reconstitution.’ Using a rules-based and transparent process, the index is formed by listing all companies in descending order of market capitalization. The top 1,000 of these companies make up the large-cap Russell 1000 Index, which accounts for 93% of the Russell 3000 stocks. As of

December 31, 2023, the weighted average market capitalization of the stocks in the Russell 1000 was $666 billion, with a median market capitalization of $13.9 billion. The next 2,000 companies make up the small-cap Russell 2000 Index.

The dataset used in this study consists of stock trading data from January 1, 2000, to December 31, 2023, covering two important stock indices: the Russell 2000 and the Russell 1000. The Russell 2000 index consists primarily of small companies; the total number of companies downloaded from Yahoo was originally 1,941 firms, but after a process of culling the data and restricting the timeline, a total of 1,235 component companies were included to satisfy the 2,000 or more data volume. The Russell 1000 Index, on the other hand, includes big companies, and like the Small Company Index, the data downloaded from the internet shows a total of 1,005 companies, with a total of 841 constituents adjusted for inclusion in our analyses. These data are representative of the overall performance of the U.S. stock market for both small and medium-sized companies and big companies. The stock data from Yahoo Finance contains a daily 'adjust close price' from which we can get the daily return. There is the 'trading volume' and we can calculate the daily volatility from the returns.

2.1.3 Fama-French five-factor

This is because not only do we use OLS regressions for stock returns, volatility, and trading volume, but we also use the Fama-French five-factor model for further analysis of returns. The data for the Fama-French five-factor model are collected from Fama-French's website. These include Market risk-free rate (RF), Market risk premium (Mkt-RF), Size Premium (SML), Value premium (HML), Profitability premium (RMW) and Investment Style Premium (CMA). These factors are used to analyze their impact on stock returns. The goal of this model is to predict and explain the sentiment influences on the stock returns more accurately by taking these factors into account.

2.2 Methodology

The analyses in this paper are based on Ordinary Least Squares (OLS) regression models to investigate how sentiment affects the different dimensions of the stock market: returns, trading volume, and volatility. In each model, sentiment indices are used as independent variables, while stock returns, trading volume, and volatility are used as dependent variables, respectively. Each model is executed independently and each response variable is analyzed separately. The general regression equation stated:

$$E(y_{i,t}) = \alpha_i + \beta_i \cdot SENT_t \,, \tag{1}$$

where $y_{i,t}$ is the dependent variable, α_i is the intercept term, β_i is the regression coefficient corresponding to the sentiment index, and $SENT_t$ is the sentiment index in time *t*. Returns are commonly calculated in financial research as the relative change in stock prices from the previous day to the current day. In this way, the absolute change in stock prices can be converted into a comparable relative rate of change, which facilitates comparisons between stocks of different sizes and price levels. The formula is shown below.

$$r_{i,t} = \frac{p_{i,t}}{p_{i,t-1}} - 1 \,. \tag{2}$$

In this formula, $r_{i,t}$ represents the daily return of stock *i* at time *t*, and $p_{i,t}$ and $p_{i,t-1}$ represent the closing price of the stock at time *t* and time *t*-1. This formula reflects the relative change in stock prices from the previous day to the current day and is a commonly used return calculation method in financial research. In this way, absolute changes in stock prices can be converted into comparable relative rates of change, facilitating comparisons between stocks of different sizes and price levels.

Volatility is usually calculated using the GARCH (1,1) model, which is an important measure of the degree of price volatility. This model assumes that fluctuations in an asset's price

are not random, but depend on previous fluctuations. The formula of the GARCH model we used in this study is as follows:

$$r_{i,t} = \mu_i + \sigma_{i,t} \cdot \epsilon_{i,t} \,, \tag{3}$$

$$\sigma_{i,t}^2 = \omega + a \cdot \sigma_{i,t-1}^2 + b \cdot \epsilon_{t-j}^2 \,, \tag{4}$$

where $r_{i,t}$ is the return on asset *i* at time *t*, μ_i the average return on asset *i*, which is usually assumed to be a constant, $\sigma_{i,t}$ is the volatility of asset *i* at time *t*, and $\epsilon_{i,t}$ is the random disturbance term of the standard normal distribution (i.e., $\epsilon_{i,t} \sim$ N(0,1)). $\sigma_{i,t}^2$ is the square of the volatility of asset *i* at time *t*. ω, a, and b are model parameters that need to be estimated from historical data. ω is the mean of the long-run volatility, a is the effect of the previous period's volatility on the current volatility, and b is the effect of innovations (i.e., stochastic perturbations) in the previous j periods on the current volatility.

The Fama-French 5-factor model is an extension of the Capital Asset Pricing Model (CAPM), proposed by Eugene Fama and Kenneth French in 2015. This model better explains stock returns by introducing five different factors. The sentiment factor is specifically included as a variable in our analysis to analyze the influence of the sentiment factor on returns. The formula we used in our analysis is as follows:

$$\begin{aligned} E(r_{i,t}) - r_{f,t} = \alpha_i + \beta_{1,i} \cdot MKT_t + \beta_{2,i} \cdot SMB_t + \beta_{3,i} \cdot HML_t \\ + \beta_{4,i} \cdot RMW_t + \beta_{5,i} \cdot CMA_t + \gamma_i \cdot SENT_t \,, \end{aligned} \tag{5}$$

where $E(r_{i,t})$ is the expected return of stock *i* at time *t*, $r_{f,t}$ is the risk-free return, α_i is the intercept term, and all β parameters quantify the extent to which each factor affects stock returns. MKT_t refers to the market excess return at time *t*, SMB is the Small Minus Big, the difference between the returns of small-capitalization stocks and the returns of large-capitalization stocks. HML is High Minus Low, the difference between the returns of high book-to-market ratio stocks and low book-to-market ratio stocks, RMW is Robust Minus Weak, the difference between the returns of strongly profitable firms and those of less profitable firms. CMA is the Conservative Minus Aggressive, the difference between the returns of low-investment firms and those of highly invested firms.

To compare the results, we first used the Shapiro-Wilk test to determine if our results fit a normal distribution. The Shapiro-Wilk test is an efficient way to detect whether the data is from a normal distribution. The formula for its test statistic W is given below:

$$W = \frac{(\sum_{i=1}^{n} a_i x_{(i)})^2}{\sum_{i=1}^{n} (x_i - \bar{x})^2} \,, \tag{6}$$

where $x_{(i)}$ denotes the *i*th value of the *i*th sample data after arranging them in order from smallest to largest. $\bar{x}$ is the mean value of the sample data. a_i is a set of constants that depend on the sample size *n* and can be obtained by looking up tables or using statistical software.

The Mann-Whitney test (also known as the Mann-Whitney U test) is a non-parametric statistical method for comparing the medians of two independent samples to determine whether they come from the same distribution. The test does not assume that the data follow a particular distribution, and is therefore particularly useful when dealing with data that do not conform to a normal distribution. This matched the situation where none of our data conformed to a normal distribution, hence we used this test in our analysis of the data. The formula is below:

$$U_1 = n_1 \cdot n_2 + \frac{n_1 \cdot (n_1 + 1)}{2} - R_1 \,, \tag{7}$$

$$U_2 = n_1 \cdot n_2 + \frac{n_2 \cdot (n_2 + 1)}{2} - R_2 \,, \tag{8}$$

where n_1 and n_2 are the sizes of the two samples respectively. R_1 and R_2 are the rank sums of the two samples.

3. Results

In this section, we present the empirical findings.

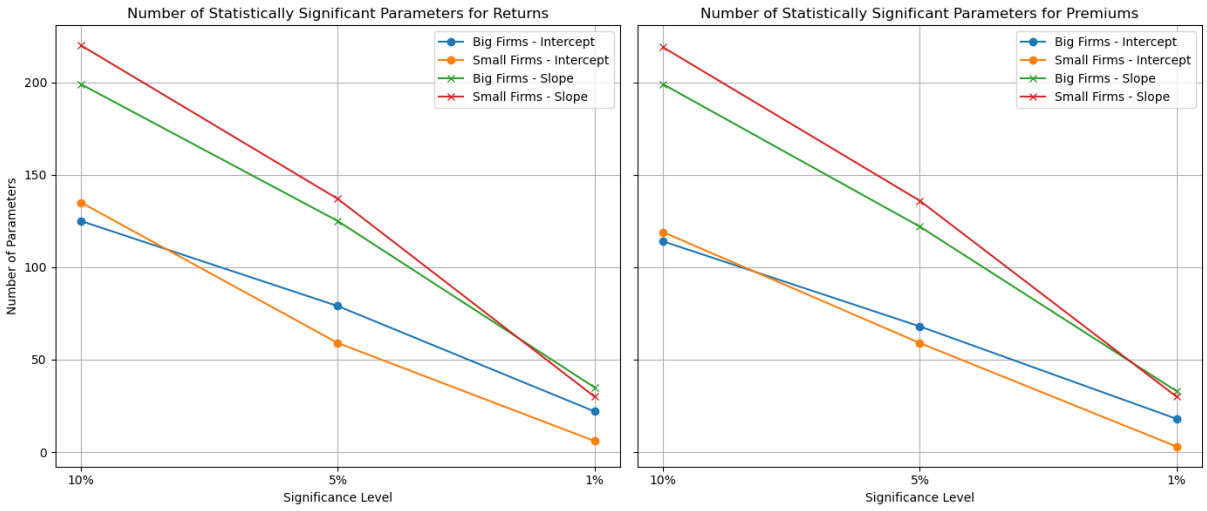
3.1 Returns and premiums (returns minus risk-free rate)

Table 1 and Figure 1 show statistically significant regression parameters of return and premium on sentiment for big and small companies. The sample size for small firms (1,235) is larger than for big firms (841). At the 5% significance level, the number of significant slopes for return and premium is relatively low for both firm sizes, indicating limited explanatory power of sentiment on returns and premiums. Despite the larger sample size, small firms show less significance at lower levels (e.g., 1%). As the significance level decreases, the number of significant intercepts and slopes for returns and premiums decreases more sharply for small firms than for big firms. This suggests that big firms' baseline performance is more stable and less affected by sentiment changes.

Table 1: Quantities of statistically significant parameters of regression of return (left) and premium (right) on sentiment for big companies and small companies.

Significance Level	Regression parameter	Return (Big)	Return (Small)	Premium (Big)	Premium (Small)
10%	Intercept	125	135	114	119
	Slope	199	220	199	219
5%	Intercept	79	59	68	59
	Slope	125	137	122	136
1%	Intercept	22	6	18	3
	Slope	35	30	33	30

Figure 1: Quantities of statistically significant parameters of regression of return (left) and premium (right) on sentiment for big companies and small companies.



From Figure 2, the intercept values for big firms are tightly grouped around zero, while small firms show more outliers, indicating greater sensitivity to sentiment. The slopes for both firm sizes are concentrated around zero, suggesting a minimal direct effect of sentiment on returns.

Figure 2: Parameter values of return regression for big and small companies.

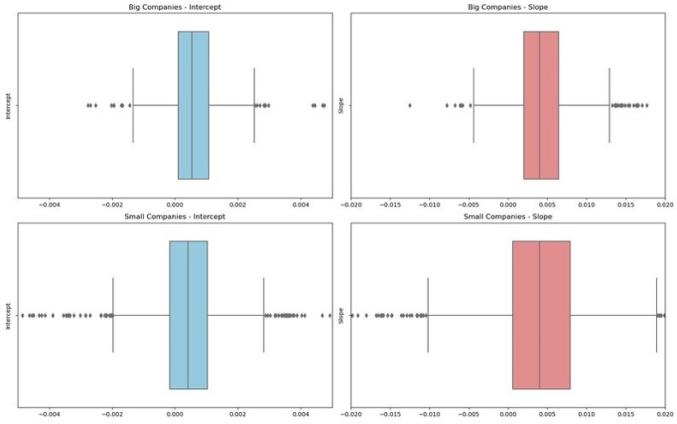


Table 2 shows the Mann-Whitney test results, indicating a significant difference in intercepts between big and small firms ($p<0.01$) but not in slopes ($p=0.78$). Table 3 shows that big firms have higher mean and median intercepts than small firms, reflecting higher underlying returns. Small firms are slightly more sensitive to sentiment, as indicated by the average slopes, but both firm sizes respond similarly to sentiment changes.

Table 1: Mann-Whitney test for return's parameters between big and small companies.

Regression parameter	U Statistic	P Value	Effect Size
Intercept	563652.0	P<0.01	3.637205
Slope	518883.0	0.78	0.278313

Table 2: Comparison of return's parameters between big and small companies.

Metric		Mean	Median
Intercept	Big	0.000588203	0.000533998
	Small	0.000482604	0.000412782
Slope	Big	0.004268543	0.004026729
	Small	0.004696173	0.004026864

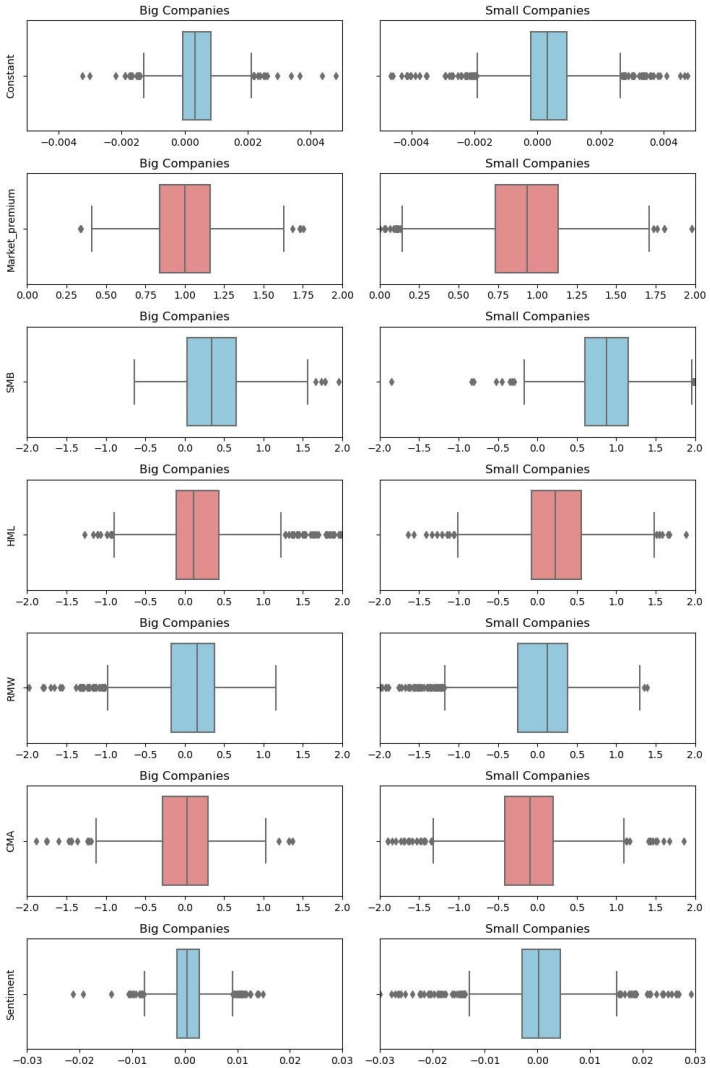
3.2 Sentiment and Fama-French factors

Our analysis using the Fama-French five-factor model (Table 4) shows that the number of significant parameters for small firms is generally higher than for big firms across most significance levels. This indicates small firms are more sensitive to market factors. Market excess return (Mkt_minus_RF) significantly impacts both types of firms, with a high number of significant parameters. Small firms exhibit higher sensitivity to size (SMB), value (HML), investment (RMW), and profitability (CMA) factors, especially at the 1% significance level, reflecting their responsiveness to market and financial indicators. The number of significant slopes is higher for small firms, suggesting a greater impact of sentiment on their stock returns. According to Figure 3, Mkt-RF has a significant effect on returns for both types of firms, whilst SMB and HML have a more pronounced positive effect on smaller firms, suggesting that smaller firms are more sensitive to size and value factors. Sentiment has a small effect on both types of firms, but more inconsistently on smaller firms.

Table 3: Quantities of statistically significant parameters of regression of Fama-French 5 factors model on sentiment for big and small companies.

Significance Level	Regression parameter	Big	Small
5%	Intercept	85	99
	Mkt_minus_RF	836	1188
	SMB	612	1109
	HML	539	721
	RMW	491	549
	CMA	341	339
	Slope	58	80
1%	Intercept	36	21
	Mkt_minus_RF	836	1172
	SMB	547	1051
	HML	473	582
	RMW	395	397
	CMA	244	209
	Slope	12	21

Figure 3: Parameter values of Fama-French 5 factors model regression for big and small companies.



The Mann-Whitney test (Table 5) indicates no significant difference in intercepts, RMW, or sentiment slopes between big and small firms. However, Mkt_minus_RF, SMB, HML, and CMA differ significantly. Table 6 shows that big firms have slightly lower mean intercepts but higher medians compared to small firms. Small firms have higher means and medians for SMB and HML, indicating stronger responses. Sentiment slopes show higher means for small firms and higher medians for big firms, suggesting similar sentiment effects on both.

Table 4: Mann-Whitney test for FF-5-factors model's parameters between big and small companies.

Regression parameter	U Statistic	P Value	Effect Size
Intercept	524160.0	0.5	0.674232
Mkt_minus_RF	592482.0	P<0.01	5.800239
SMB	198858.0	P<0.01	-23.732260
HML	462449.0	P<0.01	-3.955771
RMW	525406.0	0.443	0.767716
CMA	583339.0	P<0.01	5.114265
Slope	523665.0	0.524	0.637093

Table 5 : Comparison of Fama-French 5 factors model's parameters between big and small companies.

Regression parameter		Mean	Median
FF5F_intercept	Big	0.000377226	0.000324796
	Small	0.000409437	0.000312784
Mkt_minus_RF_slope	Big	1.004973651	0.999357572
	Small	0.914562554	0.93718552
SMB_slope	Big	0.364320319	0.343603271
	Small	0.894040467	0.881375053
HML_slope	Big	0.176290472	0.113221457
	Small	0.231512766	0.230282889
RMW_slope	Big	0.041323934	0.157155643
	Small	-0.008045109	0.127699138
CMA_slope	Big	-0.019619662	0.027955429
	Small	-0.110460468	-0.095566439
Sentiment_slope	Big	0.000705142	0.000500614
	Small	0.001159595	0.000292704

3.3 Sentiment and volatility

Table 7 shows significant slope parameters for big and small firms' volatility on sentiment at different significance levels. At the 5% level, big firms have 711 significant slopes, and small firms have 981. At 1%, big firms have 664, and small firms have 911. The number of significant slopes decreases with stricter significance levels, indicating pervasive sentiment effects on volatility. Small firms have more significant slopes in absolute numbers, but big firms have a higher proportion relative to their sample size, implying that sentiment impacts big firms' volatility more significantly. The intercept remains constant across significance levels, suggesting stable baseline volatility for both firm sizes when sentiment is zero. At the 5% level, almost all big (99.524%) and small (99.676%) firms are significant at the intercept level, indicating a significant correlation between baseline volatility and sentiment for most firms.

Figure 4 shows that big firms have a narrower volatility range (0.02 to 0.03) with fewer outliers, suggesting lower baseline volatility. Small firms have a wider range (0.02 to 0.04) and more outliers, indicating higher baseline volatility and greater sensitivity to sentiment. The slope distribution for big firms is centered around zero, indicating consistent sentiment responses. Small firms' slopes range from -0.02 to 0, showing more variability. Sentiment

impact on volatility is relatively small and similar for both firm sizes, emphasizing the consistent market response to sentiment.

Table 6: Quantities of statistically significant parameters of regression of volatility on sentiment for big and small companies.

Significance Level	Regression parameter	Volatility (Big)	Volatility (Small)
10%	Intercept	837	1231
	Slope	733	1022
5%	Intercept	837	1231
	Slope	711	981
1%	Intercept	837	1231
	Slope	664	911

Figure 4: Parameter values of volatility regression for big and small companies.

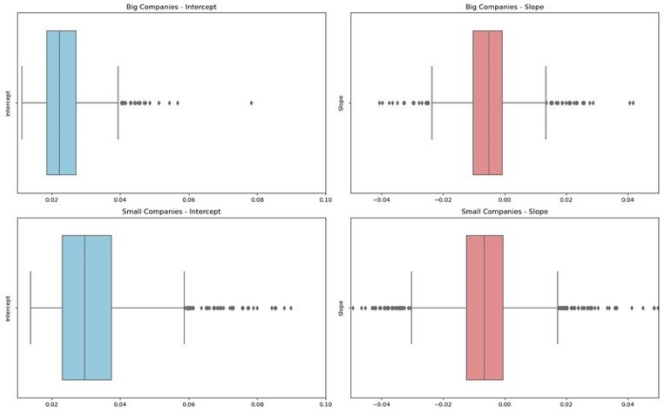


Table 7: Mann-Whitney test for volatility's parameters between big and small companies.

Regression parameter	U Statistic	P Value	Effect Size
Intercept	275087.0	P<0.01	-18.01301
Slope	551754.0	P<0.01	2.74453

Table 8: Comparison volatility's parameters between big and small companies.

Metric		Mean	Median
Intercept	Big	0.02362	0.02222
	Small	0.03363	0.02963
Slope	Big	-0.00515	-0.00504
	Small	-0.00563	-0.00654

The Mann-Whitney test (Table 8) indicates significant differences between big and small firms in intercept and slope of volatility. Table 9 shows that small firms have higher baseline volatility than big firms. Both firm sizes have negative slopes, indicating that increased sentiment generally reduces volatility, with a more significant effect on smaller firms.

3.4 Sentiment and traded volume

Table 10 shows that at the 5% significance level, there are 837 significant intercepts for big firms and 1229 for small firms. The proportion of significant intercepts is 99.524% for big firms and 99.514% for small firms. For slopes, there are 657 significant results for big firms and 827 for small firms, with proportions of 78.121% and 66.964%, respectively. This indicates that big

firms show more significant results for both intercept and slope, suggesting their trading volume is more influenced by sentiment due to a dynamic market environment.

Figure 5 illustrates that the median intercept for big firms is higher, indicating higher underlying trading volume without sentiment changes. The volume for big firms fluctuates more widely with extreme values. Small firms have a lower, more consistent trading volume. The median slope for big firms is close to zero but generally negative, showing that sentiment decreases trading volume. Small firms' slopes are closer to zero and less volatile.

Table 9: Quantities of statistically significant parameters of regression of volume on sentiment for big and small companies.

Significance Level	Regression parameter	Volume (Big)	Volume (Small)
10%	Intercept	837	1231
	Slope	689	896
5%	Intercept	837	1229
	Slope	657	827
1%	Intercept	837	1229
	Slope	586	709

Figure 5: Parameter values of volume regression for big and small companies.

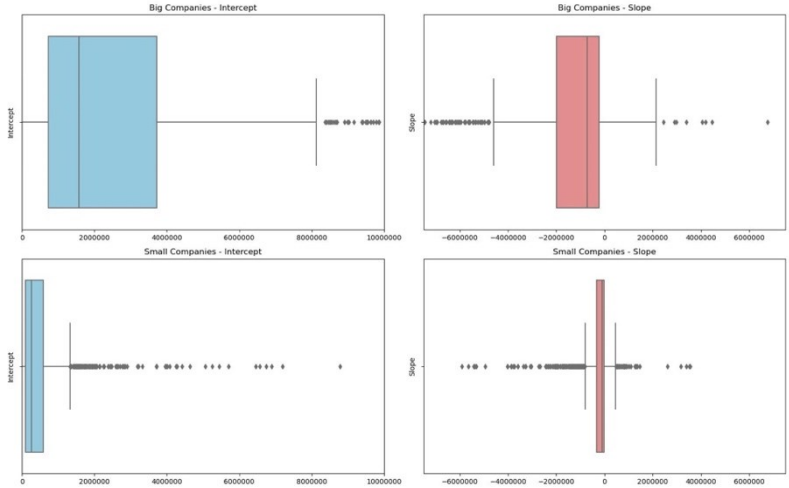


Table 10: Mann-Whitney test for volume's parameters between big and small companies.

Regression parameter	U Statistic	P Value	Effect Size
Intercept	887915.5	P<0.01	27.965781
Slope	261907.5	P<0.01	-19.001834

Table 11: Comparison volume's parameters between big and small companies.

Metric		Mean	Median
Intercept	Big	4630236.974	1572292.850
	Small	517883.267	252878.8196
Slope	Big	-1878285.271	-723274.564
	Small	-323839.504	-104630.578

The Mann-Whitney test in Table 11 shows significant differences between big and small firms in intercept and slope ($p<0.01$), indicating different sentiment impacts on trading volume. Table 12 reveals that the mean and median intercepts for big firms are much higher than for small firms, confirming that big firms have higher baseline trading volumes.

4. Discussion and conclusion

Our comparison of returns, factors from the Fama-French five-factor model, volatility, and trading volume shows that sentiment impacts big and small firms differently. Sentiment has limited explanatory power for returns and premiums for both firm types. Big firms exhibit higher baseline levels without sentiment influence due to their larger market size. Small firms are more sensitive to market factors like SMB, HML, and CMA. Sentiment affects volatility similarly for both, with a slightly greater impact on small firms, indicating more noise traders in small firms. In terms of trading volume, big firms show more significant results in intercepts and slopes, suggesting a higher sensitivity to sentiment fluctuations due to their dynamic market environment. This is consistent with other findings on sentiment and volatility. Although different sentiment indices are used in different countries, numerous studies have shown that sentiment is negatively correlated with both volatility and trading volume. However, comparisons of the extent to which large-cap and small-cap firms are affected by sentiment vary across countries, cultures, and markets.

To summarize, investor sentiment plays different roles in companies of different sizes. Sentiment has a greater impact on the volatility of smaller firms and a more significant effect on the trading volume of larger firms. This is because larger firms have more stable and transparent management structures, which can reduce investor uncertainty and concerns, thereby mitigating sentiment-driven volatility. Additionally, larger firms tend to have more sophisticated market strategies, including business diversification and advanced risk management techniques. These strategies can mitigate investor sentiment by spreading risk and reducing the impact of a single event on a company's overall performance.

For individual investors, the market positioning and strategic objectives of different companies will attract different types of investors. For example, growth companies may be more susceptible to investor sentiment, while stable companies are more likely to attract conservative investors looking for stable returns and relatively less volatile sentiment. A sound internal control system can effectively monitor and manage various risks, ensure the compliance and safety of the company's operations, and reduce negative market sentiment due to internal problems. Good internal controls include timely and accurate information disclosure and effective communication with investors. This helps reduce information asymmetry and market rumors, stabilizing investor sentiment. Through these mechanisms, differences in management structure, market strategies, and internal controls can directly or indirectly affect investor confidence and sentiment toward the company, thereby influencing stock prices and market performance. Understanding and managing investor sentiment, especially under extreme conditions, is critical to developing effective investment strategies and maintaining market stability.

This study enhances our understanding of how investor sentiment affects stock market characteristics and highlights the different responses of firms of varying sizes. Future research could explore the interaction between sentiment and other market variables and seek more data to better represent investor sentiment for explaining stock market anomalies.

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Employing Creative Accounting Methods – Motivations, Risks, and Identification

Jan Pěta, Pavla Srbová [1]

Abstract

Financial statements are an important source of information about a company for external users. Based on this information, many decisions are made, such as whether to buy the company or to provide a loan. Knowing this, company representatives may modify financial statement data using the creative accounting techniques. The reason is to improve the company's image in terms of meeting economic criteria or increasing the company's profitability. Several European studies report that up to 90% of companies present inaccurate information in their financial statements. Researchers use mathematical models (mainly the Beneish M-score model) to identify this tendency. Investments in such companies run the risk of failing to achieve the planned economic value or, in the worst case, of a complete devaluation of the investment, i.e. in case of bankruptcy of the company.

Key words

Creative accounting, Beneish model, risk, value of company

JEL Classification: G32, M41

1. Introduction

Financial statements are the primary information source for many users, especially those outside the company. These external users use information from the balance sheet and income statement to analyse the financial health of the company (e.g., using Altman's Z-score) or to determine the business value. Adámiková and Čorejová (2021) expected that the COVID-19 pandemic would increase the companies' interest in using creative accounting techniques. The scientific community agrees with this assumption, as the number of articles and their citations is growing in the recent years.

Ado et al. (2022) defined creative accounting as "an accounting practice that may or may not abide by the rules of accounting standard practices but clearly deviates from these rules and regulations." Consequently, the desired values are presented instead of the real values (Blazek et al., 2023). Misleading the external environment of companies and hiding the true results is the main reason for using this practice. We would like to emphasise that these practices take advantage of the variability of accounting legislation and are not considered as a fraud.

Creative accounting involves various attempts to influence financial reporting. Stangova and Vighova (2016) highlighted fixed assets as a possible area for creative accounting. They considered the difference between accounting and tax depreciation, the difference between technical improvement and repair, and the classification of incidental acquisition costs as problematic areas. Remenarić et al. (2018) expanded this area to include changes in accounting policies, overestimation of revenues by recording fictitious sales revenues, manipulation of receivables write-offs, and manipulation of accruals.

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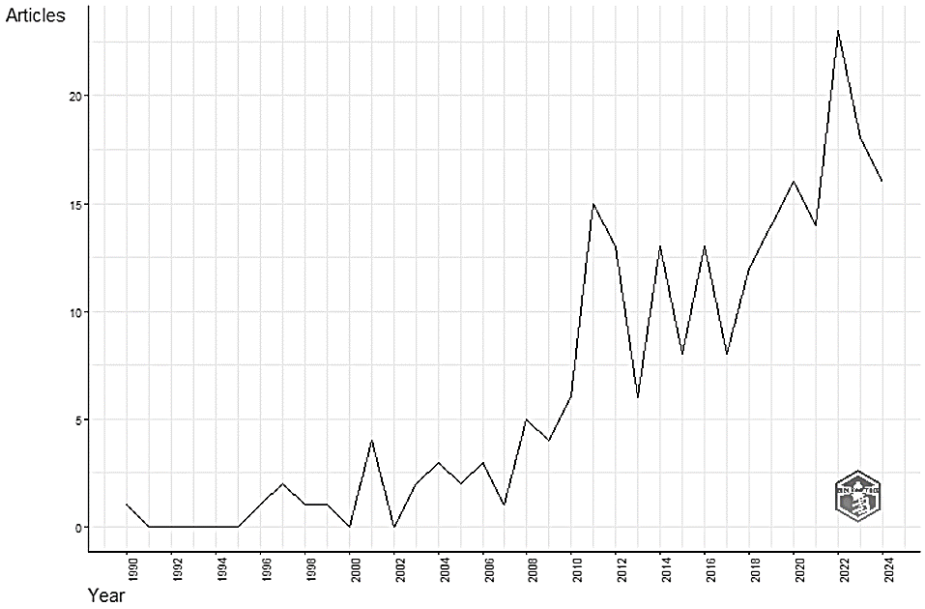
Drábková and Pech (2022) divided the techniques used in creative accounting into the following groups: overvaluation of operating cash flow, overstatement financial health, incorrectly classifying profit and loss items, and overvaluation of earnings. The most common accounting adjustments identified by Blazek et al. (2023) are fictional revenue growth, depreciation adjustments, and misstatement of assets or liabilities, including off-balance sheet items.

The aim of this article is to examine how creative accounting affects the accuracy of financial statements and the subsequent risks for investors, emphasizing the application of mathematical models like the Beneish M-score to identify financial manipulation. In addition to summarizing findings from the literature, we present results from a bibliometric analysis. To identify the scientific publications focused on creative accounting, we used the data from the Scopus and WOS databases, applying the *bibliometrix* R-package (Aria and Cuccurullo, 2017). The analysis includes publications that feature "creative accounting" as a keyword, with 68 duplicates removed from the dataset.

2. Creative accounting

Below we present the most relevant and interesting findings from the bibliometric analysis of the creative accounting literature. The analysis highlights key trends, influential publications and areas of research that provide valuable insights into the field.

Figure 1: Trend in the number of scientific publications



The number of publications dealing with creative accounting is increasing, as can be seen in Figure 1. Figure 2 shows that the highest number of publications comes from the University of Žilina, followed by the Bucharest University of Economic Studies. The analysis (see Figure 3) identified five authors, namely Drábková Z. from the Czech Republic, Finch N. and Carlin T. from Australia, Blažek R. and Durana P. from Slovakia, with have the highest number of publications on creative accounting. The analysis also shows that authors from different institutions generally do not cooperate in research.

Figure 2: Most relevant affiliation of published research

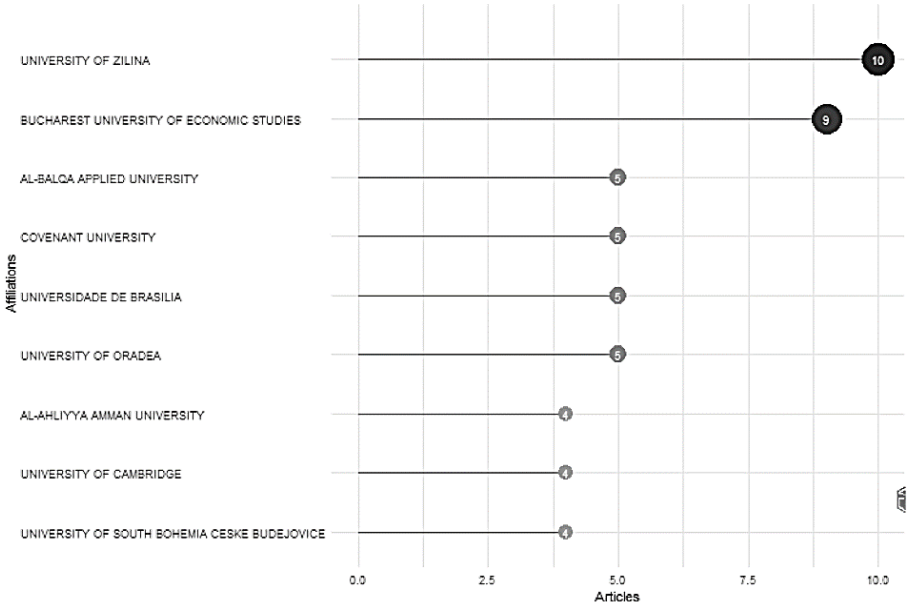
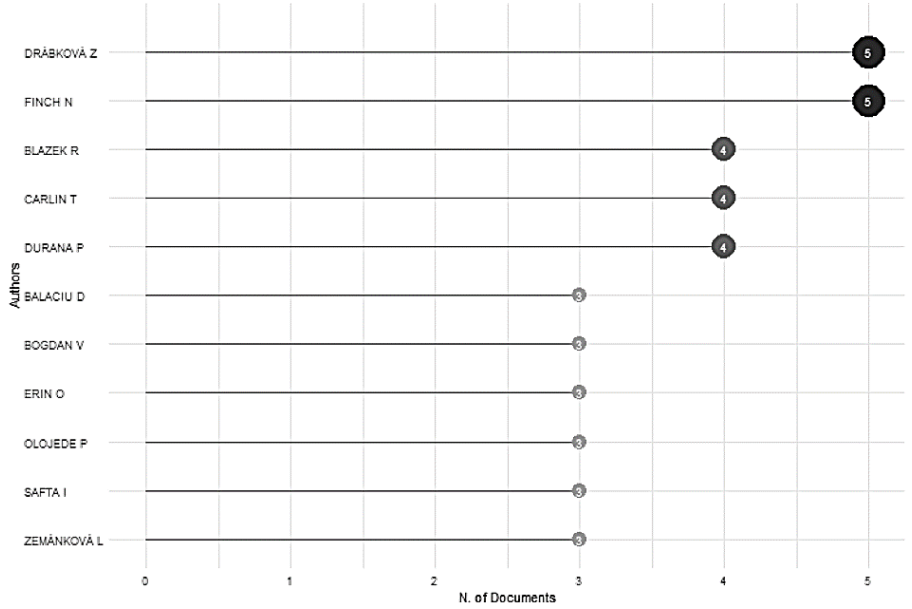


Figure 3: Most relevant authors of published research



Buljubasic Musanovic and Helilbegovic (2021) examined the financial health of bankrupt companies in Bosnia and Herzegovina and how these companies used creative accounting techniques. They first used Altman's Z-score to measure the economic performance of bankrupt companies. The model correctly identified only 29 of the 65 companies that subsequently went bankrupt, with 11 in the grey area and 25 identified as healthy. One third of the 25 misidentified companies were found to have an abnormal increase in Z-score, indicating the use of creative accounting techniques, according to Beneish's M-score.

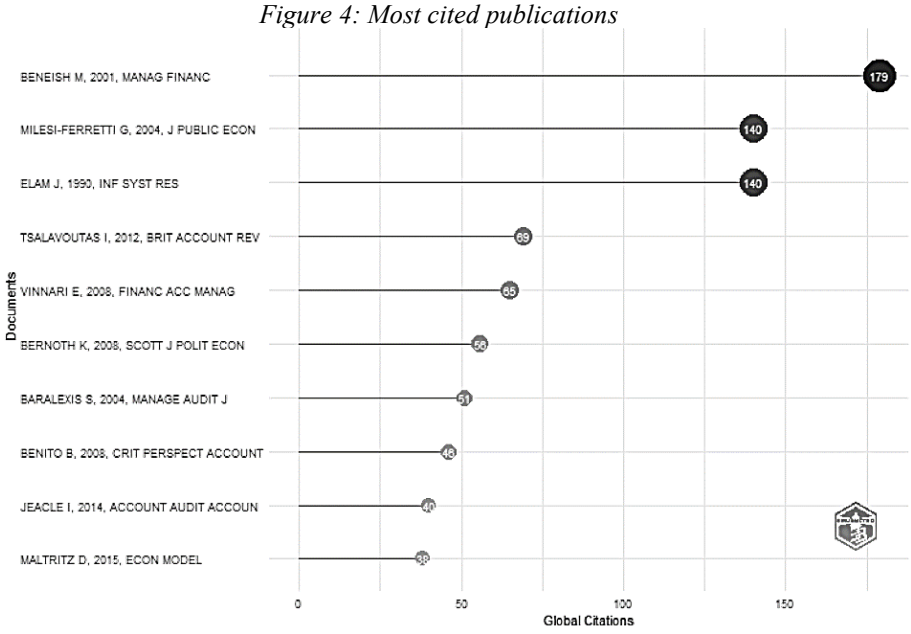
Similar research was conducted by Valaskova et al. (2021), who used the chi-square test to identify a statistically significant link between financial distress and the use of creative accounting.

Amel-Zadeh et al. (2016) research focused on the business valuation in the context of creative accounting techniques. He used the example of Vodafone's acquisition of Mannesmann in 2000. Given the price of the acquisition, the goodwill was determined to be £83 billion. There were four ways to post that goodwill as a cost. Depending on the method used, the value of the

equity in the year of acquisition could have ranged from £60 billion to £160 billion, and the cumulative profit over the six years following the transaction could have ranged from zero to a total loss of £71 billion. All four methods were legal.

The above examples show that the use of creative accounting has significant consequences and risks for the users of financial statements. These include the failure to achieve the predicted economic outcomes, the devaluation of the investment, and, in the worst case, the complete destruction of the investment, i.e., the bankruptcy of the investee company. To avoid these risks, various methods are used to identify creative accounting techniques.

Figure 4: Most cited publications



One of the most widely used models to test the use of creative accounting is the Beneish M-score presented by Beneish (1999), which is also the most cited article, followed by Milesi-Ferretti (2004) and Elam and Mead (1990) – see Figure 4. Milesi-Ferretti (2004) examined whether fiscal rules lead to fiscal adjustment or encourage creative accounting, with the evidence depending on the extent of creative accounting and budget transparency. And the last mentioned (Elam and Mead, 1990) looked at decision support systems and how they affect the creativity by experimenting with auditors. Finally, Figure 5 shows that key words often used together with 'creative accounting' are earnings management, earnings, performance, cost accounting, manipulation, debt, deficits or income.

Figure 5: Frequently used keywords together with 'creative accounting'

2.1 Identifying creative accounting

The Beneish M-Score model, introduced in 1999, is used to determine whether a company uses creative accounting techniques (e.g. Blazek et al., 2020; Kovalová and Frajtová Michalíková, 2020; Safta et al., 2020; Adámiková and Čorejová, 2021; Buljubasic Musanovic and Halilbegovic, 2021 or Durana et al., 2022):

$$\text{M-Score} = -4.84 + 0.92 * \text{DSRI} + 0.528 * \text{GMI} + 0.404 * \text{AQI} + 0.892 * \text{SGI} + \\ + 0.115 * \text{DEPI} - 0.172 * \text{SGAI} + 4.679 * \text{TATA} - 0.327 * \text{LVGI}$$

where: DSRI is Days' sales in a receivable index, GMI is Gross margin index, AQI is Asset quality index, SGI is Sales growth index, DEPI is Depreciation index, SGAI is Sales and general and administrative expenses index, LVGI is Leverage index and TATA is Total accruals to total assets.

The model was established on the basis of data from 74 companies that manipulated their earnings and the comparison with more than 2 thousand companies that did not manipulate their profit. Therefore, the author Beneish (1999) pointed out that the model is focuses mainly on the items that influence the profit and is not able to consider important changes within the company, such as changes in strategy, acquisitions or changes in the economic environment.

Under the model's original assumptions, the important cut-off point is -2.22. If the company result is below this point, the company is probably unlikely to use creative accounting. Conversely, if the score is higher, the company is likely to use creative accounting techniques.

The Beneish model was used by other authors to develop various models to identify the risk of financial statement manipulation in their countries. Blazek et al. (2023) added a cut-off value of +2.22. This value divides companies into potentially manipulative and manipulative (handling area). Cut-off values may vary across countries. Buljubasic Musanovic and Halilbegovic (2021) report an adjusted value of -1.78 for companies in Bosnia and Herzegovina. Similarly, Safta et al. (2020) mention a modified model. They classified companies' results into three groups: area of no financial fraud risk, an uncertain or grey area, and a financial fraud risk area.

The next method used to identify creative accounting is the Jones model and its variants (for more details see Durana et al., 2022):

$$\frac{\text{NDA}_{it}}{\text{A}_{it-1}} = \text{a}_0 \frac{1}{\text{A}_{it-1}} + \text{a}_1 \frac{\Delta\text{REV}_{it} - \Delta\text{REC}_{it}}{\text{A}_{it-1}} + \text{a}_2 \frac{\text{PPE}_{it}}{\text{A}_{it-1}} + \varepsilon_{it}$$

where: NDA_{it} is non-discretionary accrual in a year t, TA_{it} is total accrual in a year t, A_{it-1} is total assets in a year t-1, ΔREV_{it} is annual change in revenue in year t, ΔREC_{it} is annual change in receivables in year t, PPE_{it} is long-term tangible assets in a year t, α_0, α_1, α_2 are coefficients and ε_{it} is prediction error.

Other methods can also be used to determine whether a company uses creative accounting (see Blazek et al., 2023). As an example, they refer to the CFEBT model, i.e. the method that analyses the development of cash flows (CF) and earnings before tax (EBT). The formula is:

$$\text{CFEBT} = \sum_{t=1}^{5} \left(\frac{\Delta\text{CF}_t - \text{EBT}_t}{\text{EBT}_t} \right)$$

The risk of financial statement manipulation increases if the CFEBT is higher than 5 to 10%. In this case, finding detailed reasons for the changes between CF and the economic result is important.

2.2 Current research results

Blazek et al. (2023) conducted their research using the data of 7006 companies from V4 during the period of 2019 to 2021. Their results showed that the COVID-19 pandemic increased the percentage of companies identified as using creative accounting techniques. Between 87% and 89% of companies used these techniques in each year analysed. The proportion of companies that clearly manipulated accounting results increased from 41% to 49%. Among the key financial ratios that were manipulated, the research identified the ratio of total accruals to total assets for almost 90% of the companies. About half of the companies manipulated the sales and general and administrative expenses index.

Durana et al. (2022) focused their research on Slovak companies in 2016-2018. They used the Beneish model and found that about 90% of companies used creative accounting techniques. They tried to identify the macroeconomic causes. In all years analysed, the most important factor was corruption, followed by tax rates and bureaucracy.

Safta et al. (2020) conducted the research on 62 Romanian companies between the years 2017-2018. They found that about 84% of all companies used creative accounting, mainly including the companies from the tourism, construction and transport sectors.

In addition to research focusing on the number of companies using creative accounting techniques, we can also see different lines of the research. Others (e.g. Gajdosikova et al., 2022) have examined how creative accounting techniques are related to industry classification and legal status. These studies suggest that public companies increase earnings by managing the bottom line. On the contrary, companies in the construction industry manage the bottom line by reducing earnings. The construction industry was also identified by Drábková and Pech (2022) as a sector of frequent manipulation. They identified accruals and the residual value of sold assets as problematic areas.

Kliestik et al. (2022) examined the link between the use of creative accounting and corporate governance. They found that male or mixed leadership is more likely to manipulate accounting than female leadership. The reason for manipulating financial results is to improve the company's image and thus the management's personal reputation.

Drábková a Pech (2022) tried to identify the motives of the reasons for using the techniques of creative accounting. In addition to the above-mentioned reasons (tax reasons and managerial reasons), they also identified these motives: growing interest of investors, pressure from competitors or strengthening of credit rating.

3. Conclusion

We can conclude that the use of creative accounting is relatively common standard for companies, even within the countries of the Visegrad Group. Various motives lead to this practice, such as achieving the planned economic results, reducing tax payments or gender representation in management. The use of creative accounting techniques can negatively influence the business environment that makes decisions based on the financial statements.

Investors make decisions based on available inaccurate information when the company uses creative accounting. The decision may have been different if the correct data were available. As a result, the objectives may not be achieved (e.g. the projected business value may not be in line because the forecast was based on modified historical business data). It can also lead to a decrease in the investment value or bankruptcy of the investee company. To eliminate these risks, we can use various models such as the Beneish M-score model or the Jones model. These models can also be used to calculate whether Czech companies use creative accounting.

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Coordination of Expectations in Multi-Asset Pricing Experiment

Michaela Sedláková[1]

Abstract

We study the coordination of expectations in a multi-asset pricing Learning to Forecast experiment. Subjects are asked to predict the price of three risky assets simultaneously. At the beginning of the experiment, they receive an initial price history for these risky investment options. One asset has a stable initial price history close to its fundamental value, while the other two assets exhibit more volatile price histories. Our investigation centres on the impact of this initial price history on participants' coordination of expectations. Our key findings are as follows: (i) across all experiments, participants exhibit high coordination, (ii) greater heterogeneity emerges when there is a trend shift towards decreasing prices, and (iii) stable initial price history tends to foster stronger coordination among participants compared to more volatile assets.

Key words

experimental economics, expectations, asset pricing

JEL Classification: C92, D84, G12, G41

1. Introduction

Expectations significantly influence investment decision-making and aggregate market dynamics. Learning to Forecast (LtF) experiments allow us to explore how individuals form their expectations and how these expectations impact financial markets and macroeconomics. In behavioral finance, LtF experiments are commonly employed to test hypotheses regarding how people form expectations, which may differ from rational ones. Participants in these experiments typically play the role of professional forecasters, tasked with setting expectations for various economic indicators, such as asset prices and inflation rates.

At the VSB – Technical University of Ostrava, we conducted a Learning to Forecast (LtF) experiment involving students from the Faculty of Economics who had the role of financial forecasters for a pension fund. Our experimental framework was based on Anufriev et al. (2022), where participants obtained an initial price history of the risky asset. Unlike previous LtF experiments that focused on a single risky asset, our study expanded the investment options to include three risky assets. For these assets, we provided initial price histories, with one asset characterized by a stable historical price development compared to the other two. In contrast to previous experiments that focused on a single risky asset, participants can now compare the price development of each individual asset with other assets in the market.

The objective of this paper is to examine how the initial price history impacts the coordination of expectations among participants. Our hypothesis posits that asset with a stable initial price history will foster greater coordination compared to more volatile assets.

The approach to studying expectation formation in controlled environment was introduced by Marimon et al. (1993), where they analyzed price forecasts in an overlapping generations

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model. Traditionally, the LtF experiments are mainly focused on questions related to asset pricing where participant play the role of a financial forecaster. Review of LtF experiments can be found in Hommes (2011) and Bao et al. (2021).

Investigating participant coordination constitutes a traditional aspect of data analysis in LtF experiments. Hommes et al. (2008) investigated the expectation formation in a stationary asset pricing experiment with constant fundamental value of an asset. However, significant price bubbles were evident in most of the experiments. From their further analysis, it is clear that participants were highly coordinated and followed a common prediction strategy. The effect of framing on asset price dynamics was studied in Hanaki et al. (2019), where treatments were differentiated by the data presentation (observation of prices or returns) and task (prediction of prices or returns). They concluded that the level of coordination is similar between treatments. In most cases, participants were highly coordinated. Hommes et al. (2021) explored the emergence of bubbles in a laboratory experiment with large groups of individuals. They found that large asset bubbles are robust in large groups and that bubbles are strongly amplified by coordination on trend extrapolation.

This contribution is organized as follows. First, the experimental design and asset pricing model are introduced in Section 2. Next, Section 3 devotes analysis of experimental results with focus on the impact of initial price history on coordination of expectations. Finally, in Section 4, we present our conclusions.

2. Experimental design

Between October and November 2022, as well as in April and May 2023, six experiments were conducted at the VSB – Technical University of Ostrava. These experiments involved 75 students from the Faculty of Economics, with group sizes ranging from 9 to 17 students. The experiments took place in a computer classroom, where all participants operated within the same market throughout the entire session. At the start of each experiment, participants received detailed instructions, including printed copies, and were acquainted with their task. During the experiment, participants were not allowed to communicate with each other. After completing the experiment, students filled out a questionnaire and received payment based on their ranking. Payment amounts varied from 50 to 700 CZK, and the ranking was determined by their average prediction error.

This section is organized as follows. First, the experimental design is introduced in Section 2.1. Next, the asset pricing model is presented in Section 2.2 and our hypothesis is stated in Section 2.3.

2.1 General information about experiment

The experimental design is based on the experimental design in Anufriev et al. (2022). Participants are introduced to the experiment in the following way. Participants play the role of a financial forecaster for a pension fund that needs to optimally invest a large amount of money for a single period. The pension fund has several investment options: a risk-free asset and three risky assets. Explicit instructions clarify that the risky assets are uncorrelated in long-term. For the risk-free asset, funds are invested in a government bond with a fixed interest rate of 5%. Alternatively, a pension fund can allocate funds to shares of indefinitely existing risky assets. These assets are associated with uncertainty regarding future prices and dividends, which are independently and identically distributed with a mean of $10 per period.

Participants' main objective is to predict future asset prices, based on which the pension fund will make trading decisions. While the instructions do not specify the exact pricing equation, they highlight certain market quality characteristics. For instance, higher price forecasts lead to increased asset demand, and multiple funds collectively influence total demand. Additionally, we extend our research to the number of risky assets with distinct

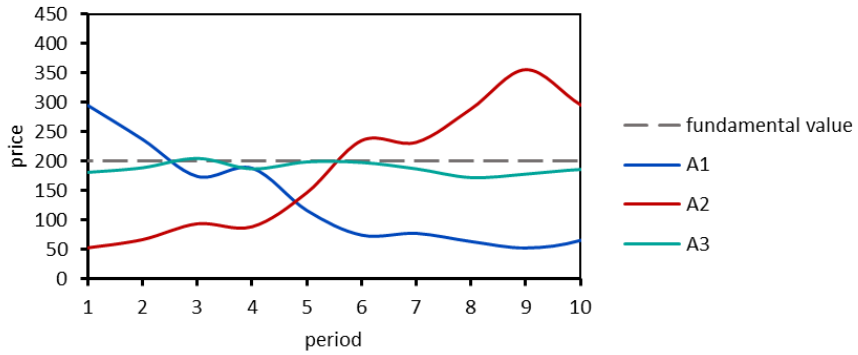
initial price histories. Specifically, assets A1 and A2 exhibit greater volatility, while asset A3 maintains a stable price development around its fundamental value (see Figure 1). Importantly, all these assets share a fundamental value of $200.

During the experiment, participant's available information for the price prediction of the period $t+1$ in period t consists of:

- past realized prices up to period $t-1$,
- participant's previous price predictions up to period t,
- the total average error of the participant, as well as the average errors for particular assets.

Once all predictions from all participants for period $t+1$ were received, the realized price of assets for the current period t was determined according to equation (1) and this was repeated for all 50 consecutive periods.

Figure 1: Initial price history for all risky assets



2.2 Asset pricing model

The experimental design is based on the typical LtF experimental set up, incorporating the present value model of asset pricing. Mean-variance investors divide their wealth into risk free and risky assets. The gross return of risk-free asset is $R=1+r>1$ and all risky assets pay an IID dividend with mean $\bar{y}$ each period. The market-clearing price $p_{t,a}$ of an asset a in a time period t is defined according to Brocks and Hommes (1998) as follows,

$$p_{t,a} = p_a^f + \frac{1}{(1+r)}\left(\bar{p}^e_{t+1,a} - p_a^f - \varepsilon_{t,a}\right), \tag{1}$$

where p_a^f is fundamental value of particular asset a which is calculated as a present value of dividend payment $p_a^f = \bar{y}_a / r$, r is discount factor, $\bar{p}^e_{t+1,a}$ are average expectations about price in the period $t+1$ for the asset a, and $\varepsilon_{t,a}$ is a small random outside supply of the asset from noise traders.

It is obvious from equation (1) that the market price $p_{t,a}$ is a weighted average of the fundamental value and average expectations for the period $t+1$. If an increase in price is expected in the future, it increases the demand in the current period as well as the price. This is called positive expectations feedback. The rational equilibrium is given by the fundamental value of the asset.

2.3 Hypothesis

In our experiment, participants received information about the short-term initial price history of three risky assets. Figure 1 highlights that asset A3 exhibits consistent development

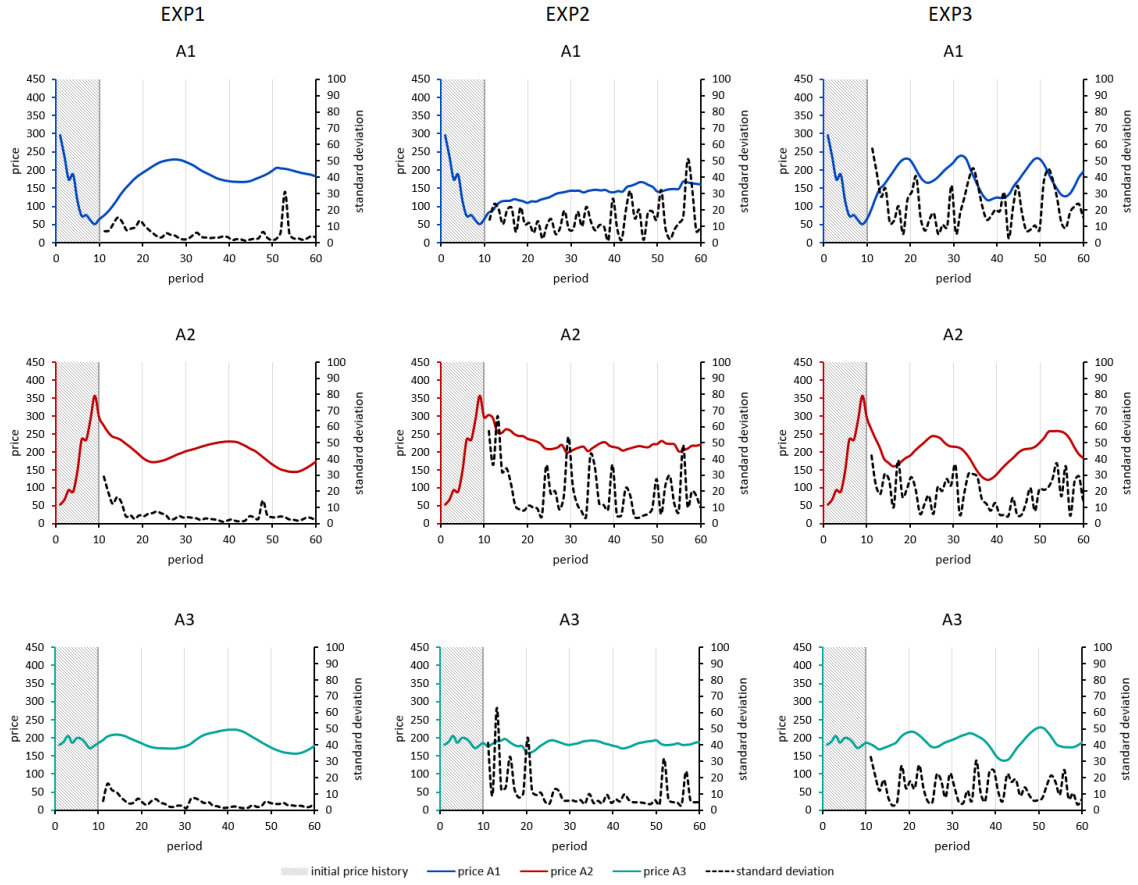
around its fundamental value compared to the other assets. Our investigation focuses on how this initial price history impacts expectation coordination. We use the standard deviation of participants' predictions as a measure of coordination. Our hypothesis is as follows:

Hypothesis: *A stable initial price history for asset A3 results in greater coordination in forecasts compared to other assets.*

3. Experimental results

We begin by discussing stable markets characterized by relatively small deviations of realised prices from fundamental value (EXP1, EXP2, EXP3). Next, we explore coordination in markets with medium-sized bubbles (EXP4, EXP5, EXP6). Finally, we test our hypothesis regarding the impact of initial price history on participants' coordination.

Figure 2 Realised prices (left scale) and standard deviation of forecasts (right scale) for stable markets



Our discussion begins with an examination of participant coordination in stable markets. Figure 2 illustrates the combined graph of realized prices and the standard deviation of participants' forecasts. In EXP1, the market remains highly stable, with small deviations of realized prices from the fundamental value. Throughout the experiment, participants exhibit very high coordination, reflected by consistently low forecast standard deviations. In EXP2, during the initial periods for assets A2 and A3, participants' predictions show higher heterogeneity. This is also typical in some other experiments and is related to participants learning how to make accurate predictions. Notably, asset A3, characterized by stable historical development, demonstrates stronger participant coordination. In EXP3, we observe a more pronounced deviation of realized prices from the fundamental value compared to EXP1. Interestingly, there appears to be a pattern: as asset prices increase, participant

coordination tends to rise. However, when the trend changes to a decline, we typically see higher heterogeneity in participants' predictions. Returning to the comparison of asset A3 with other assets, it consistently exhibits a lower prediction standard deviation.

Next, we analyze coordination in markets with medium-sized bubbles. In EXP4, realized asset prices remain relatively stable until approximately the 25th period. Initially, predictions show higher heterogeneity, but later, the standard deviation in predictions becomes very low, indicating significant coordination among participants. Similar to EXP3, we observe increased forecast heterogenity when the trend in realized prices shifts downward. When comparing the level of coordination for asset A3 with other assets in the market, it becomes evident that asset A3 exhibits greater coordination. EXP5 is characterized by oscillations of realized prices around the fundamental value, the amplitude of which is decreasing. This is also associated with a higher degree of fluctuations in the coordination of participants. Asset A3 again exhibits the highest degree of participant coordination. In the case of EXP6, it can be seen that all assets exhibit similar levels of coordination.

Figure 3 Realised prices (left scale) and standard deviation of forecasts (right scale) for markets with medium sized bubbles

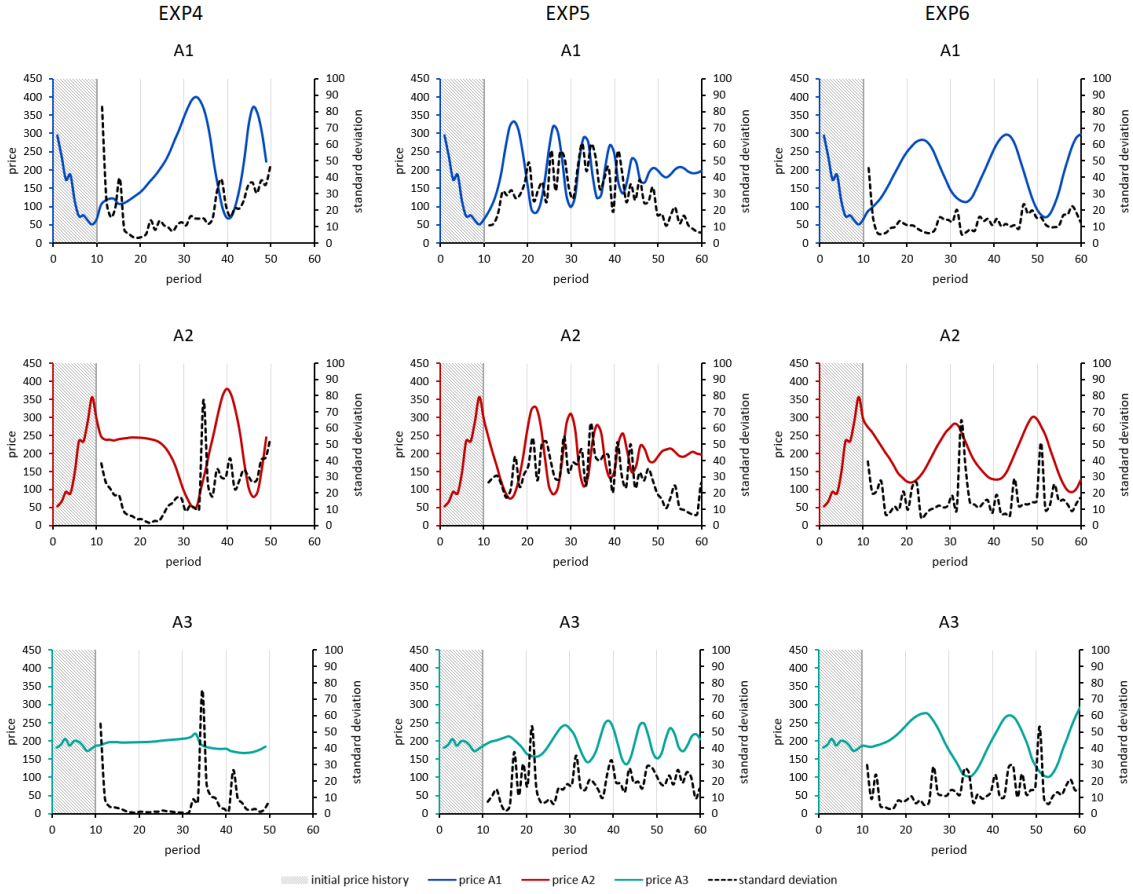


Table 1 summarizes the average standard deviation and participants'predictions across all periods for each asset. The ratio of these two quantities represents the average coefficient of variation, which serves as another measure of coordination. The resulting coefficient of variation values indicate relatively low heterogeneity across all experiments, suggesting that participants adhere to a common prediction strategy.

Table 1: Average of forecast standard deviation, price forecast and coefficient of variation for particular assets per each experiment

Experiment	Asset	Average standard deviation of forecasts	Mean of price forecasts	Average coefficient of variation*
EXP1	A1	5,21	183,03	2,84%
	A2	5,3	195,93	2,71%
	A3	4,34	188,64	2,30%
EXP2	A1	14,56	134,82	10,80%
	A2	19,13	224,38	8,53%
	A3	10,86	182,35	5,95%
EXP3	A1	22,06	175,5	12,57%
	A2	19,48	200,57	9,71%
	A3	13,56	187,63	7,23%
EXP4	A1	20,36	216,03	9,43%
	A2	21,39	208,3	10,27%
	A3	7,36	189,24	3,89%
EXP5	A1	30,28	197,17	15,36%
	A2	30,57	191,8	15,94%
	A3	18,25	195,1	9,35%
EXP6	A1	12,75	190,52	6,69%
	A2	16,83	189,62	8,87%
	A3	14,25	195,77	7,28%

**Coefficient of variation is calculated as average standard deviation of forecasts divided by mean of price forecasts per asset over time.*

We now proceed to test our hypothesis based on the visual results discussed earlier, aiming to infer the possible influence of initial price history on participants' coordination. As previously mentioned, asset A3 exhibits a stable historical development around the fundamental value, while assets A1 and A2 have more volatile price histories. To test our hypothesis, we employ the Mann-Whitney one-sided test due to data non-normality. The test will consistently compare the standard deviation of predictions for asset A3 with one of the more volatile assets.

Table 2 summarizes the p-values of the test. The results indicate a statistically significant effect of initial price history on participants' coordination in 8 out of 12 cases at the 5% significance level. The only exceptions are EXP1 and EXP6, where the coordination of participants remains similar across all assets in the market.

Table 2: P-values from Mann–Whitney test one-tailed test comparing the standard deviation of forecasts

Asset	EXP1	EXP2	EXP3	EXP4	EXP5	EXP6
A1	0,3984	0,0002***	0,0002***	0,0001***	0,0001***	0,3853
A2	0,3166	0,0001***	0,002***	0,0001***	0,0001***	0,0594*

*Note: *, ** and *** denote asset comparisons when the null hypothesis is rejected at the 10%, 5% or 1% significance level, respectively.*

4. Conclusion

In this contribution, we explored the impact of initial price history on participant coordination through a Learning to Forecast experiment. Our investigation was grounded in a straightforward experimental asset pricing model. Unlike previous LtF experiments that primarily focused on predicting the price of a single risky asset over consecutive periods, we extended our research to markets with three uncorrelated risky assets. This extension enabled us to explore whether participants' coordination is influenced by the initial price history.

Overall, the results indicate that participants' coordination was consistently high on average. At the beginning of the experiment, we observed greater variability in participants' predictions, likely due to their initial learning phase in making accurate forecasts. During the trend change from increasing to decreasing prices, coordination decreased. By examining different initial asset price histories, we investigated their impact on coordination. Our hypothesis that the stable price history of asset A3 leads to lower heterogeneity compared to other assets was tested. The results show that in 8 out of 12 cases, the initial price history significantly affected participants' coordination.

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An Approach for Setting a Safe Harbour for the Loans Based on Freely Available Data: A Reasonable Way or Just Virtue Out of Necessity

Veronika Solilová[1], Karel Brychta[2], Michal Ištok[3]

Abstract

With regards to strict laws outlined in the Income Tax Act and the lack of specific methodology/guidelines in the OECD Transfer Pricing Guidelines, taxpayers are experiencing significant legal ambiguity and high compliance costs when determining the transfer price of intercompany loans (i.e. transactions between associated persons). For this reason, a number of states have implemented simplified measures, known as "safe harbours", which offer substantial advantages both for taxpayers and tax authorities. The purpose of this paper is to introduce a potential safe harbour strategy by assessing the predictive capabilities of the Bloomberg and Czech National Bank (CNB) databases in order to establish a safe harbour considering the conditions of the Czech Republic.

Key words

Comparative study, financial transactions, safe harbour, transfer pricing, Bloomberg, Czech National Bank

JEL Classification: H25, K34.

1. Introduction

In 2022, special standards for financial transactions such as cash-pooling, hedging, financial guarantees, captive insurance, and loans were introduced by the recent OECD Transfer Pricing Guidelines update. This update was eagerly awaited since it introduces important factors that need to be taken into consideration when determining the arm´s length price. One important factor to consider is the assessment of the creditworthiness of the borrowers, which refers to their ability to repay the principal amount borrowed plus the accrued interest. The credit rating assigned by rating agencies, based on their qualitative and quantitative analyses, is the most common tool used in practice to assess creditworthiness. The evaluation of the borrower´s credit rating is therefore the key feature of the transfer pricing analysis (Gabelle In Bakker & Kale, 2021).

In practice, a building block approach (the so-called "build-up model") is a widely employed in order to determine the arm´s length price of a particular financial transaction. This approach is based on a core concept where a risk premium is assigned to the credit rating to account for the risk of the creditor not being repaid the owned amount, including interest, due to the potential default risk of the borrower. Subsequently, this value is added to the risk-free interest rate (OECD, 2022, chapter X, par. 10.105). Nevertheless, data on assigned

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ratings for European companies is scarce, with most available ratings being for North American companies. As a result, methodologies are typically based on data from North America (e.g. Damodaran, 2024). As a result, establishing transfer pricing for financial transactions based on ratings or creditworthiness poses a major challenge for European companies, leading to considerable uncertainty when addressing tax matters, particularly during audits. Moreover, the rating is a crucial factor that is essential for determining the arm's length price of interest in a financial transaction. Without it, it would be nearly impossible to accurately assess compliance costs related to transfer pricing and corporate income taxation, which are already substantial. For this reason, many tax administrations are attempting to provide some simplification to taxpayers (e.g. Pate, 2021 and Butani, 2021), which can be viewed as a reasonable measure, particularly for fundamental types of transactions.

The OECD Transfer Pricing Guidelines introduce suitable transfer pricing methods for financial transactions, including the still preferred comparable uncontrolled price (CUP), yield or cost approach, credit default swaps, economic modeling, and others. However, there are no specific standards/recommendations for financial transactions safe harbour regimes in the OECD standards. Safe harbour standards specifically for financial transactions as a simplified procedure have never been introduced. A globally accepted standard has not been established, so existing practices (concepts) vary significantly among countries. According to Ištok, Solilová & Brychta (2023), about 15 countries (such as Austria, Luxembourg, New Zealand, or South Africa) have implemented simplified procedures to determine the interest rate for financial transactions between associated entities, while 12 countries (including Australia, India, Korea, Serbia, Slovenia, Switzerland, and the United States) have directly introduced safe harbour provisions for such transactions. Chapter IV of the OECD Transfer Pricing Guidelines, which focuses on the Safe Harbour approach, currently only offers it for low value-added transactions. According to the authors of this paper, this Chapter and the standards included within it are not considered suitable, i.e. sufficient, for safe harbour in the area of financial transactions.

2. Aims and methodology

This paper aims to establish and evaluate a potential simplified regime approach for setting an interest rate for loans, known as the “safe harbour“, while utilizing alternative available data. These data include particularly statistics from the Czech National Bank and denomination for Czech crowns being considered. The main focus of this paper is to analyze the data obtained from the Bloomberg database and compare it with publicly available information from the Czech National Bank regarding interest rates on debt transactions denominated in Czech crowns.

The data sources used were the Bloomberg (2023) and CNB-ARAD (Czech National Bank, 2023) databases. Bloomberg was selected due to its common application in practice, while the CNB-ARAD database was used as a publicly available database, since it provides data from the Czech region. In the Bloomberg database, we concentrate on the bond bid option-adjusted spread (OAS) for monthly membership of the forward Bloomberg US Corporate Bond Index (LUACSTAT). This refers to the month-end spread for this forward index, which can be broken down according to sector, rating bucket, and maturity bucket. In practice, the OAS represents a robust indicator of the level of interest rate margin considered by third-party lending institutions. Furthermore, based on the Czech tax authority´s preference, only the 5-year maturity bucket was analyzed.

The CNB-ARAD database contains comprehensive credit statistics for non-financial entities and other entities. To achieve the goal of the paper, our focus is on non-financial

entities and detailed credit statistics related to loan transactions. Additionally, we only considered data from the year 2022.

3. Results and discussion

Based on the analysis of safe harbour regimes in the world, it is clear that the most common form of safe harbour is a build-up model. This model typically includes a risk-free interest rate plus a risk premium, which is set for different currencies (usually EUR, USD, and domestic currency) and lengths of the transaction (usually categorized as short-term or long-term). The varying position of the taxpayer in the transaction, whether as a debtor or creditor, and the associated different risk premium, is not frequently utilized in practice, nor is the distinction of the taxpayer´s size. Additionally, the safe harbor is typically restricted to the maximum amount of the financial transaction(s) and is always established as an optional system. Furthermore, the OECD Transfer Pricing Guidelines emphasize the importance of creditworthiness and rating in transfer pricing. However, only one country (India) has implemented a safe harbor provision taking into account this key aspect, setting applicable spreads of risk premium based on the rating range from AAA to D. Moreover, only a handful of countries establish particular requirements for the implementation of this system, such as excluding financial transactions with "low-tax countries" (i.e. tax havens – countries with a preferential/harmful tax system), taxpayer shall not generate long-term losses or be in restructuring period during the year of the application of the safe harbour (e.g. Australia) (Ištok, Solilová and Brychta, 2022).

When establishing a safe harbor, there are several approaches to consider. However, it is important to emphasize that a safe harbor (simplified regime) does not meet the requirement of determining prices based on the arm´s length principle. However, there is a requirement for a reasonable setting that enables the replication of results as market conditions evolve and adhere to economic principles (rationality in decision-making). In general, a standards-making authority should decide whether to establish safe harbor rules based on the credit rating of the borrower, as highlighted in the OECD Transfer Pricing Guidelines, or to focus on general safe harbor criteria such as currency, transaction length, and setting limits for loan amounts. When determining a safe harbor, freely and regularly available data should be prioritized over commercial data if the results are comparable in order to consider availability and cost. In the case of the Czech Republic, the key factors influencing the final decision are the predictive accuracy of Bloomberg and the Czech National Bank (CNB) database, as well as their impact on the compliance cost of taxation. As mentioned above, if the results provided by both databases are similar, it is preferable to use a concept based on publicly available data. Utilizing publicly available databases does not increase the compliance cost of taxation and administrative expenses.

3.1 Bloomberg database evaluation

According to our analysis of the Bloomberg database, we can conclude that it provides highly detailed information for the North America region. However, there is a significant lack of data for the European region when it comes to classification based on rating grades. Because of this, we utilized data from the North America region for our analysis. Additionally, following the OECD Transfer Pricing Guidelines and recommended methods for determining transfer pricing for loans, we specifically looked at the month bid option-adjusted spread (OAS) for the forward index. This is a reliable indicator of the interest rate margin level taken into account by third-party lending institutions. The OAS is available for sector categories, ratings bucket option (i.e., investment grade and speculative grade of ratings group) and for maturity buckets (i.e., 3, 5, 7, 10, 20 and 30-years). We chose a maximum

transaction length of 5 years maturity bucket, which appears to be the preferred option in this regard. The analysis results are shown in Tables 1- 4.

Table 1: 5-year maturity spread for all sectors and available rating grades

Spread 5YR		**All sectors**			
2022		**Average**	**Median**	**1. Quartile**	**3. Quartile**
AAA	Investment grade	34.53	33.78	29.24	39.49
AA		74.98	78.26	61.90	83.35
A		80.94	80.58	72.38	87.43
BBB		130.81	131.89	121.58	145.08
BB	Speculative grade	244.20	237.74	212.25	267.51

Source: own processing using (Bloomberg, 2023).

If we focus only on the creditworthiness, the Bloomberg database introduces the OAS spread breakdown according to the credit rating grade. As it is obvious from Table 1 above, the median values raise between 0.33 up to 1.31 % at investment grade, and up to 2.37 % at speculative grade. However, results can differ based on the industry where the borrower operates its business activities.

The Bloomberg database covers OAS results disaggregated by rating grade, industry, and maturity. However, the automatic breakdown is only available from an industry, rating, or maturity perspective, and not all-together. To obtain such a detailed breakdown, individual data processing is necessary. Therefore, the three-sided view is not readily accessible, which we see as a major drawback. If the standard-setting body wishes to establish safe harbors with such a detailed breakdown, it would raise administrative and compliance costs for taxation.

Table 2: 5-year maturity spread for individual ratings in investment grade and non-financial sector

2022 YR	**Rating**	**Average**	**Median**	**1. Quartile**	**3. Quartile**
Non-financial sector 5 Investment rating	AAA	35.69	31.51	21.84	45.04
	AA+	39.28	40.86	34.71	45.68
	AA	43.45	31.86	25.00	44.05
	AA-	51.30	47.22	37.80	61.06
	A+	77.77	63.92	52.11	86.45
	A	69.60	68.50	51.47	81.42
	A-	84.40	82.12	66.20	99.11
	BBB+	108.16	103.24	87.32	129.57
	BBB	120.21	120.73	100.47	141.39
	BBB-	174.98	174.81	143.63	202.03
Total	A - BBB-	96.15	87.51	60.10	123.85
	min	7.67			
	max	320.12			

Source: own processing (Bloomberg, 2023).

Furthermore, the OAS spread differs significantly in individual rating grades and industry sectors. The highest spreads were identified in the junk rating grade, which is not surprising (see Table 3 below). Entities with such credit rating are considered very risky with high default probability. Therefore, lending institutions expect higher interest margins. Median value of spread is approximately 10 %, although average value is more than 17 %, in comparison with just only 0.87 % (resp. 0.96 % in average) in case of investment grade. Additionally, the disparity between the median and the mean increases significantly as the rating grades decrease. The values from the lowest rating grades have a substantial impact on

the overall median value when all rating grades are taken into account. The median value of all rating grades without junk grade is significantly lower, particularly at 1.72 % in comparison with 2.45 % covering junk grade.

Table 3: 5-year maturity spread for non-financial sector and ratings

2022	Average	Median	1. Quartile	3. Quartile	Min.	Max.
All rating grades	500.65	245.82	94.54	506.95	7.43	18884.40
All rating grades without junk grade	243.32	172.92	84.15	355.90	7.67	1549.59
Investment grade	96.15	87.51	60.10	123.85	7.67	320.12
Speculative grade	416.21	373.87	283.68	504.00	144.66	1549.59
Junk grade	1762.17	1019.21	709.92	2117.96	313.89	18884.40

Notes: Speculative grade represents credit rating BB+, BB, BB-, B+, B, B-. Junk grade represents credit rating CCC+, CCC, CCC-, CC, C and D.
Source: own processing using (Bloomberg, 2023).

In terms of the number of entities with ratings and available OAS, the majority are from non-financial sectors with investment and speculative grade ratings. The marginal portion consists of entities with a low credit rating, specifically only 101 entities. The financial sector also shows a significant decrease in entities with a speculative or low rating, with only 61 entities being the exception (see Table 4).

Table 4: Number of entities having rating at 31 December 2022, for 5-year maturity

Credit rating grade	Non-financial sector	Financial sector	Total
Investment	799	502	1 301
Speculative	564	51	615
Junk	101	10	111
Total	**1 464**	**563**	**2 027**

Source: own processing using (Bloomberg, 2023).

This outcome would validate the transfer pricing viewpoint in the event of a financial transaction involving a loan. Generally, companies with junk credit ratings are unable to secure financing from financial markets for their preferred forms of funding due to the high risk of default they pose. If they are granted access, it is typically subject to certain specific conditions that restrict their activities (such as limitations on asset disposal). Similarly, when dealing with related parties, it is important to assess whether the entity is a key part of the group´s strategy and whether there is a high risk of default. However, once the financial transaction is finalized, it is important to review all terms and determine if it is still classified as a loan or if it should be considered a capital contribution. The tax authority should also take a similar stance on this matter. However, as is evident, this reclassification of financial transactions should be done on a case-by-case basis, as some institutions that provided financing chose to lend to these entities despite the high probability of default. To take such a significant risk, they requested a very high interest margin (the 3rd quartile value is 21%), as shown in Table 3 above.

3.2 ARAD database evaluation through the CNB

Based on the analysis of the CNB database, specifically the ARAD database, several statistics can be taken into account for the creation of a safe harbour. The ARAD database not only includes general statistics, but also provides detailed credit statistics for non-financial entities. This includes data on interest rates for new contracts, contracts lasting up to 1 year, contracts lasting 1 to 5 years, and contracts lasting over 5 years. It also includes information on existing loans, loans up to CZK 30 million, loans over CZK 30 million, all on a monthly

basis. It also offers information on the overall cost of borrowing for these entities, monitors both short-term and long-term expenses, and total costs for loans provided to them (on a monthly basis).

The index monitors the yields of Czech government bonds ranging from 1 to 10 years, as well as it tracks the daily interest rate swap (IRS) for 1 to 10 years and monthly basis for 1 to 15 years. It also keeps an eye on the interest rate differentials between PRIBOR/EURIBOR and PRIBOR/LIBOR on a daily basis, as well as forward rate agreements (FRA CZ) for standard periods of 1, 3, 6, 9 months to 3 months. Additionally, it offers daily statistics for PRIBOR (2W, 1M, 3M, 6M, 12M), Repo rates, Lombard rates, and Discount rates.

However, all of this information could serve as a crucial foundation for establishing a safe harbor. Unfortunately, the database is lacking data on the credit ratings assigned to non-financial entities (such as issuer credit ratings) or issue-specific ratings that take into account specific financial obligations, classifications of financial obligations, debt seniority, as well as the creditworthiness of the guarantor, currency, and other factors. If the need for credit rating data is eliminated, the ARAD database offers valuable and detailed information that is worth considering.

3.3 Safe Harbour

When it comes to the Czech Republic, we assess the possible safe harbour options using various data sources such as Bloomberg and ARAD provided by the CNB. The main factors taken into account include OAS spread for various rating grades, 5-year maturity, currency, and loan amount.

Table 5: Safe Harbour for non-financial sector, USD bond - 1Y ago

Safe harbour for 5yr - Bloomberg database (in %)			**Average**	**Median**	**1Q**	**3Q**
A) all rating without junk grade - OAS spread, 5YR			2.43	1.73	0.84	3.56
B) rating in investment grade - OAS spread, 5YR			0.96	0.87	0.6	1.24
5YR USD bond, at 09/2023, 1Y ago	3.317					
Safe harbour for USD loans	**variant A)**	**fixed**	**5.75**	**5.05**	**4.16**	**6.88**
	variant B)	**rate**	**4.28**	**4.19**	**3.92**	**4.56**
Differential PRIBOR/LIBOR	3.15					
Safe harbour for CZK loans	**variant A)**	**fixed**	**8.90**	**8.20**	**7.31**	**10.03**
	variant B)	**rate**	**7.43**	**7.34**	**7.07**	**7.71**

Source: own processing (Bloomberg, 2023).

Table 6: Safe Harbour for non-financial sector, USD bond – range 52W

Safe harbour for 5yr - Bloomberg database (in %)			**Average**	**Median**	**1Q**	**3Q**
A) all rating without junk grade - OAS spread, 5YR			2.43	1.73	0.84	3.56
B) rating in investment grade - OAS spread, 5YR			0.96	0.87	0.6	1.24
5YR USD bond, 52W range, 09/2023						
range 3.204-4.875						
Safe harbour for USD loans	**variant A)**	**fixed**	**5.63-7.31**	**5.05-6.61**	**4.04-5.72**	**6.76-8.44**
	variant B)	**rate**	**4.16-5.84**	**4.07-5.75**	**3.80-5.47**	**4.44-6.12**
Differential PRIBOR/LIBOR	3.15					
Safe harbour for 5yr - Bloomberg database (in %)			**Average**	**Median**	**1Q**	**3Q**
Safe harbour for CZK loans	**variant A)**	**fixed**	**8.78-10.46**	**8.2-9.76**	**7.19-8.87**	**9.91-11.59**
	variant B)	**rate**	**7.31-8.99**	**7.22-8.9**	**6.95-8.62**	**7.59-9.27**

Source: own processing using (Bloomberg, 2023).

In order to determine a fixed interest rate for the country through Bloomberg database that introduces OAS spread for the North America region via credit rating, the government bond yield is to be taken into consideration. In September 2023, 52wk range of USGG5YR Index (i.e., United States 5-Year Bond Yield) was between 3.204 and 4.875 %, with 3.317 % for 1 year ago (i.e. in 09/2022). Furthermore, if we consider two rating grades, the first one including all ratings except for junk grades and the second one consisting of investment-grade ratings, we can identify two different safe harbors for fixed interest rates. Additionally, all OAS spreads were calculated for USD currency, so by using the differential between PRIBOR and LIBOR, the next safe harbor for CZK loans will also be determined (Tables 5 and 6 above).

The results show that the safe harbours fixed rate for USD loans could be around 5% (median) for all ratings except junk grade, and approximately 4% for investment grade ratings. Additionally, **the fixed rate for CZK loans in safe harbours could be higher, reaching approximately 8% for all ratings above junk grade and 7% for others.** However, when determining a transfer price, it may be more practical to consider using an interval in many situations. Table 6 shows the fixed safe harbours rate range based on the 52-week range of the USGG5YR Index. For USD loans, the rate could be between 5% and 7% for all ratings without junk grade, and between 4% and 6% for investment grade ratings. **For CZK loans, fixed rates are higher, approximately 8 to 10% for all ratings except junk grade, and between 7 to 9% for investment grade ratings, which is similar to the previous case.**

Table 7: Safe Harbour for non-financial sector, CNB, ARAD database (in %)

Data – credit statistics, average in 2022	Interest rate	Safe harbour Range*
Interest rate for 1-5 years maturity loans	7.52	6.52-8.52
Interest rate for loans	7.57	6.57-8.57
Interest rate for loans over CZK 30 mil.	7.69	6.69-8.69
Interest rate for loans up to CZK 30 mil.	6.93	5.93-7.93
Total cost of loans	7.72	6.72-8.72
Cost of borrowings	7.01	6.01-8.01

Note: * Add to each side of the range one percent point.
Source: own processing using (Czech National Bank, 2023).

To calculate the fixed interest rate using the ARAD database by the CNB for safe harbour purposes, we make one assumption. Since the database does not include information on ratings, we adjust the selected data for credit statistics by one percent point on each side of the range (Table 7 above). Based on our assumption, the safe harbour´s individual ranges would be between 6 to 8.7%, depending on the specific criteria, which closely aligns with the results obtained from the analysis of the Bloomberg data. Brychta et. al. (2023) provides more detailed information about potential approaches of setting the safe harbour in the Czech Republic in their Summary Research Report.

4. Conclusions

The purpose of this study was to assess the safe harbour determination using alternative data from the CNB in its statistics, specifically through the ARAD database. Another objective was to compare the findings with those from the commonly used Bloomberg database. The findings indicate that while the Bloomberg database offers detailed information, the results from the publicly accessible CNB statistics yield similar results for the periods examined. The suitability of the CNB database is due to certain simplifications, which form

the foundation of the safe harbour. Additionally, the use of safe harbour applies to reducing both administrative costs and compliance costs related to taxation. Moreover, taking into account that the data from the Bloomberg database pertains to the North America region, where credit rating data for the European region is lacking, the publicly accessible data specific to the Czech environment becomes even more valuable. It can be assumed that this data is better suited for local conditions. The body establishing safe harbour standards and its parameters should reflect many aspects, including the availability of data and the reproducibility of results on which the safe harbour standards are based. These aspects are of crucial importance. We believe that the data provided by the CNB is highly relevant, reasonable, and suitable for determining an appropriate safe harbour.

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Evaluating the Effect of Market Attention on Portfolio Optimization

Jialei Xiong [1]

Abstract

The objective of this study is to examine the beneficial impact of market attention on portfolio optimization. The Google Trends data for the stock codes of specific companies is used as a metric of market attention. This market attention metric is then incorporated into a suitable Google Trends model. By applying this Google Trends model, the market attention of a stock can be efficiently translated into the individual weights used for portfolio optimization. The performance generated by the Google Trends model is finally compared with the benchmark, with the result that market attention taken into account for portfolio optimisation can effectively influence portfolio performance and diversify risk.

Key words

Google Trends, portfolio optimization, rolling window, time series analysis

JEL Classification: G11, G41

1. Introduction

The Markowitz Theory (Markowitz, 1952) and the Efficient Market Hypothesis (Fama, 1970) are two fundamental assumptions of modern finance. However, since the early 1970s, more and more empirical studies have demonstrated the inadequacy of the foundations of modern finance, more and more scholars have begun to doubt the assumptions of investor rationality and market efficiency (Michaud, 1989; Black & Litterman, 1992). Furthermore, sentiment analysis has become an increasingly important factor in investment decisions.

Recent research has focused on the role played by the application of investor attention in decision-making processes. Kahnemann (1973) proposed that attention is a limited cognitive resource and that investors focus on assets with more information. Moreover, online search queries can be an effective means of identifying the prevailing investment preferences of investors. With the rapid development of the internet, online search has become an important way for individual investors to access stock market information quickly and easily. As the core tool of online search, search volume in Google Trends is used to measure attention on the web, and the interests and concerns of individual investors can often be accurately reflected by Google search volume. (Ginsberg et al., 2009; Ben-Rephael et al., 2017).

The study's objective is to evaluate the utility of market attention, as reflected in Google Trends data, in portfolio optimization. In this study, we analyze the relationship between investor attention and portfolio optimization using data from the Google Trends search engine. The diversification strategy proposed by Kristoufek (2013) is applied to explore whether the incorporation of Google Trends search intensity data in portfolio optimization diversifies portfolio risk and leads to enhanced performance. Furthermore, in order to examine the fluctuations in Google Trends search intensity for each selected stock over time and to assess its stability, we apply a rolling window approach to rebalance the Google Trends search intensity for each stock within a single window.

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The paper is structured as follows. The first section is an introduction. The second section briefly describes the methodology. The third section describes the applicable data. The fourth section describes the obtained results. The last section is the conclusion.

2. Methodology

This paper examines the utility of risk diversification using the Google Trends model developed by Kristoufek (2013). To identify in greater depth changes or outliers in the data over time in a lengthy time series, a rolling window approach was used to obtain the Google Trends of the selected stocks for each period. Subsequently, the data were applied in the Google Trends model to obtain disparate weights for each selected stock at varying levels of diversification.

Google Trends is a tool that integrates the intensity of users' searches for specific keywords in Google search, thereby enabling users to analyze trends across different time horizons and geographic regions. This study employs the portfolio diversification strategy proposed by Kristoufek (2013), which utilizes stock symbols as keywords to quantify the intensity of pertinent searches, namely the Google Trends strategy. The strategy is based on the assumption that an increase in the intensity of term searches is associated with an increase in stock risk. To determine the popularity of a stock, a weighting system is applied whereby stocks with higher search intensity are assigned lower weights, while stocks with lower search intensity are given higher weights.

Therefore, in week t, the weight of the stock i in the portfolio can be calculated as follows,

$$w_{i,t} = \frac{{V_{i,t}}^{-\beta}}{\sum_{j=1}^{n} {V_{j,t}}^{-\beta}}, \qquad (1)$$

where V represents the Google Trends search intensity for stock i in week t. It can be reasonably assumed that a higher search frequency for stock i indicates a higher search intensity.

The parameter β is used in the power law model to quantify the discriminatory impact of frequent searches on a particular stock. The β value exceeding zero indicates that stocks presenting a higher search intensity are characterized by a lower weight. Conversely, a negative value of β indicates that stocks with higher search intensity have higher weights. The β value of 0 indicates that each stock in the portfolio is assigned an equal weighting. In this study we will discuss the different weight changes due to changes in Google Trends of the selected stocks with betas between -1 and 1 at 0.1 intervals. (This means that there are a total of 21 stock weight changes due to beta in this paper). We apply the following performance as a comparison of results.

The Sharpe ratio, introduced by William Sharpe in 1966, is a key indicator for evaluating the risk-adjusted return of a financial portfolio. For the average investor, Sharpe ratio suggests that it is important to consider both risk and return when selecting "cost-effective" investments. The higher the Sharpe ratio, the higher the risk-return profile. As a result, investors typically prefer investments with higher Sharpe ratios or investments that improve the Sharpe ratio of the portfolio through diversification. The formula for calculating the Sharpe ratio is as follows,

$$Sharpe\ ratio = \frac{E(R_p) - R_f}{\sigma_p}, \qquad (2)$$

where $E(R_p)$ represents the expected rate of return on the portfolio, R_f represents the rate of return on a risk-free asset, serving as a benchmark for return achievable with minimal risk, and σ_p represents the standard deviation of the portfolio's return.

The Calmar ratio is similar to the Sharpe ratio in that it assesses the relationship between return and risk; however, the difference is that it assesses risk based on maximum drawdown.

Maximum drawdown (MDD) quantifies the maximum decline in the value of an investment, obtained from the difference between the lowest trough and the highest peak. When examining the historical return of an investment, investors often peruse the maximum drawdown indicator to understand the volatility of the return and to predict potential risk. The lower the MDD, the less volatile and less risky the investment value, while the higher the MDD, the more volatile and more risky the investment value. When comparing investment options, an investor looking for a stable return may choose the investment with a lower MDD. In contrast, investors who are willing to take on more risk in exchange for a potentially higher return may prefer assets with higher maximum drawdown values. The formula for calculating the maximum drawdown is following,

$$MDD_{(0,T)} = \underset{\tau\in(0,T)}{max}\left(1 - \frac{W(\tau)}{\underset{t\in(0,\tau)}{max}\, W(t)}\right), \qquad (3)$$

where $MDD_{(0,T)}$ represents the maximum drawdown from the beginning at time 0 to time T, and $W(\tau)$ represents the final wealth of the portfolio return at time τ.

By incorporating maximum drawdown, investors can gain a deeper understanding of the potential downside risk built into their investments. Although maximum drawdown is a risk indicator for the Calmar ratio, investors typically seek portfolios with a higher Calmar ratio because they represent an exceptional risk-adjusted return, where each unit of risk delivers a greater return. The formula for calculating the Calmar ratio is as follows,

$$Calmar\ ratio = \frac{E(R_p) - R_f}{MDD}, \qquad (4)$$

where $E(R_p)$ represents the expected rate of return on the portfolio, R_f represents the rate of return on a risk-free asset, MDD represents the maximum drawdown.

3. Data

In this paper, we have selected the top 30 constituents of the Hang Seng Index (HSI) by market capitalization as of January 2023 from among the stocks listed on the Hong Kong Stock Exchange (HKSE). The HSI is a significant indicator of the performance of Asian stock markets and a principal indicator of the overall health of the Hong Kong stock market.

The paper generates an 11-year data set from January 2013 to December 2023, consistent with the selected stocks' temporal scope. The dataset includes monthly data on stock prices, with approximately 132 months' worth of stock price information recorded.

All stock prices are presented in Hong Kong dollars. Historical data from Investing.com (5 March 2001) shows the yield on 10-year bonds in Hong Kong. The initial wealth in January 2013 is set at HK$1. The Hang Seng Index is employed as a benchmark for comparison with the results.

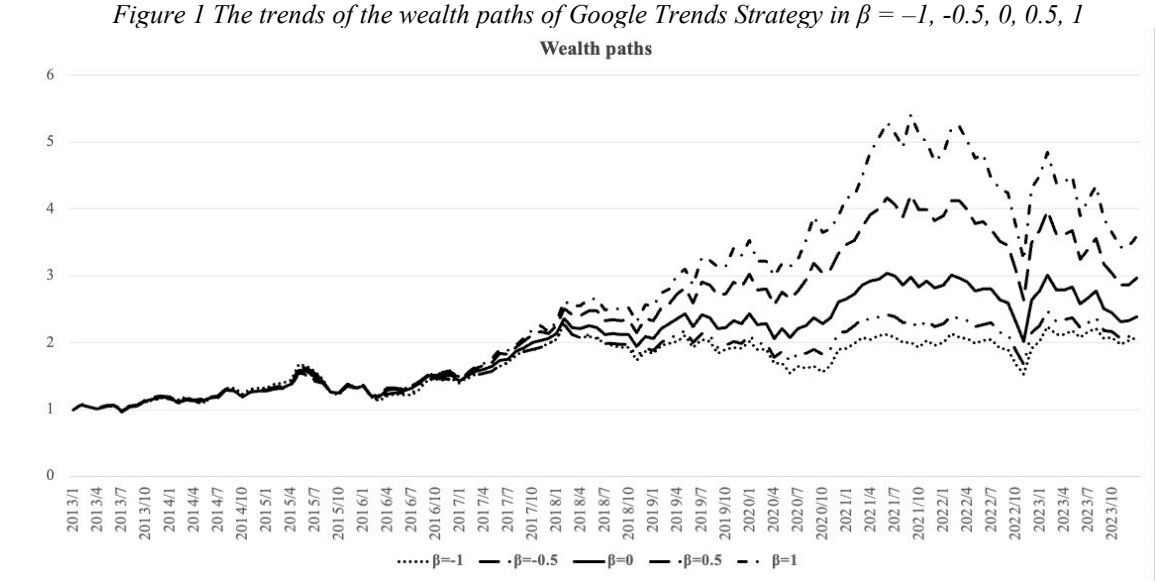
4. Results

The portfolio is rebalanced once a month. To facilitate the examination of the change in the final wealth for different settings of the power law parameter β, we selected five of the 21 available values for analysis.

The wealth paths corresponding to the five selected parameters β are shown in Figure 1. The wealth paths for these parameters show considerable similarity over the analyzed period. In addition, higher β values correlate with higher final wealth results over time. This finding of observation emphasizes the effectiveness of the Google Trends strategy in this study, which effectively reduces risk through diversification and produces better performance in terms of the

final wealth. Compared with the final wealth of the benchmark Hang Seng Index, final wealths obtained by the Google Trends strategy with different parameters of β performs better

Figure 1 The trends of the wealth paths of Google Trends Strategy in β = –1, -0.5, 0, 0.5, 1



As can be seen in Figure 1, the final wealth paths of the five βs start to differ significantly around January 2018 and the gap widens. The reason for this may be because there were unexpectedly significant gains in 2018, when the Hong Kong Exchanges IPO fundraising was the highest since 2010, according to information provided by the Hong Kong Exchanges (2024). In 2018, several new index futures options on the Hang Seng Index were added and set trading records. And there were some other influencing factors, such as a strong increase in trading volume as the Hong Kong Exchanges deepened its interconnectivity with mainland China around 2017.

In this section, we compare and analyze the three performance indicators under the benchmark and Google Trends strategy and generate the corresponding results.

Figure 2 Comparison of standard deviation between Google Trends Strategy and Hang Seng Index

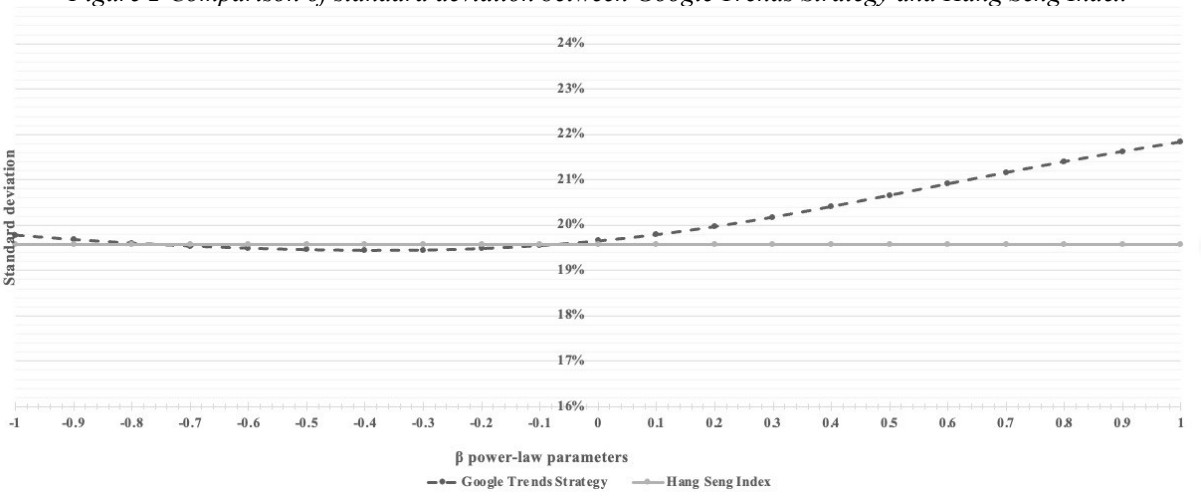


Figure 2 shows that when β is negative, the standard deviation of the Google Trends strategy remains relatively the same compared to the benchmark, and even on closer inspection, the standard deviation when β is negative is mostly lower than the standard deviation of the benchmark. However, when β becomes positive, the standard deviation of the Google Trends strategy shows a clear upward trend.

Figure 3 Comparison of Sharpe ratio between Google Trends Strategy and Hang Seng Index

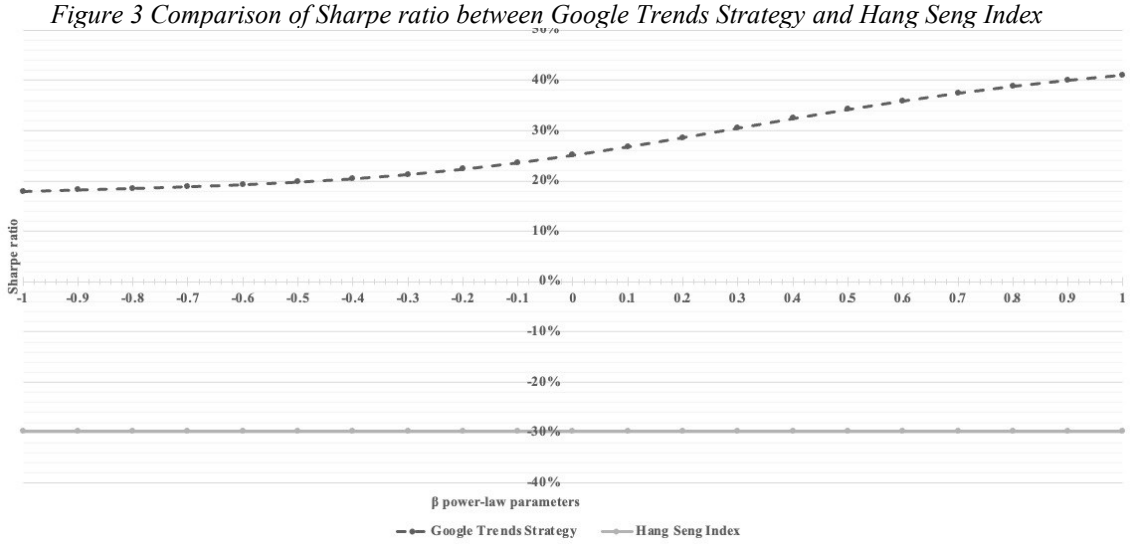
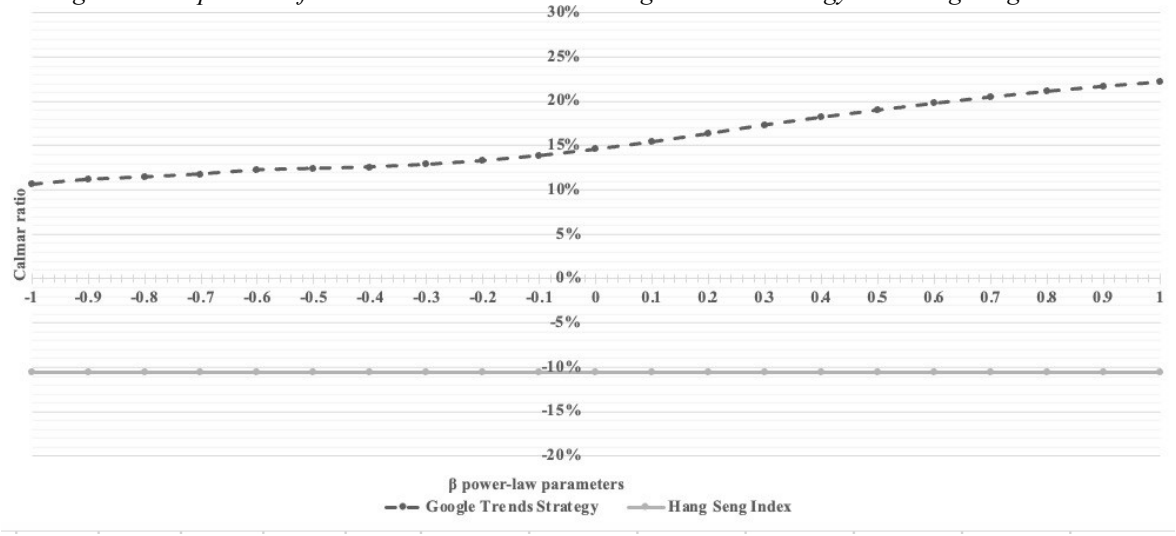


Figure 3 shows that the Sharpe ratio varies with the level of β. This is particularly evident when β is positive. When β is negative, the change in the Sharpe ratio is very small, but when β is positive, the Sharpe ratio shows a clear upward trend. Comparing the Google Trends strategy with the benchmark, it is clear that the Sharpe ratio of the Google Trends strategy is significantly better than the negative Sharpe ratio of the benchmark for different power law parameters β. Since the relationship between higher Sharpe ratios and higher risk-return ratios is clear, the Google Trends strategy outperforms the benchmark based on the Sharpe ratio as a performance indicator.

The Calmar Ratio is another measure of the relationship between risk and return. However, the Calmar Ratio measures risk based on MDD, which is different from the Sharpe Ratio.

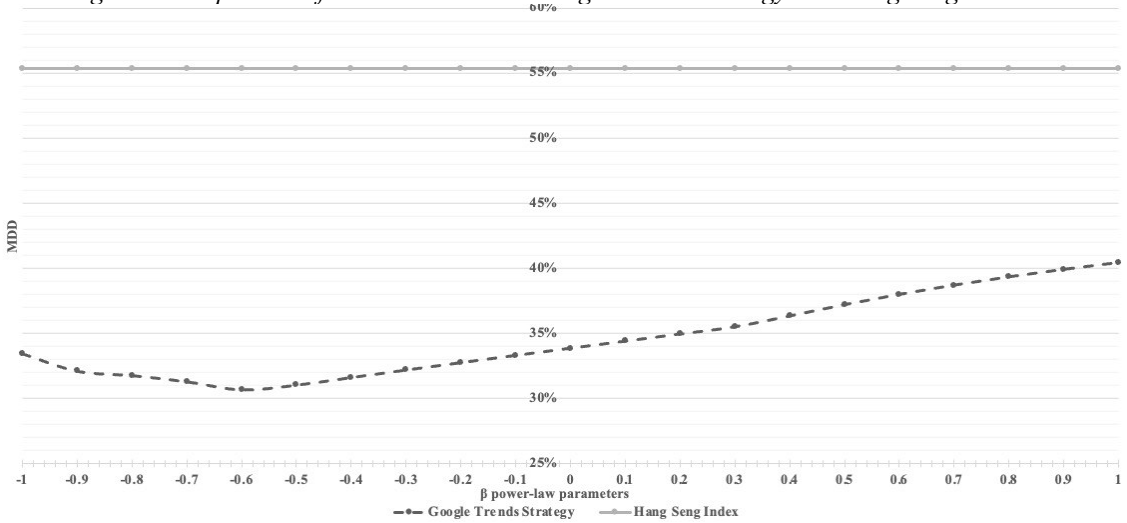
Figure 4 Comparison of the Calmar ratio between Google Trends Strategy and Hang Seng Index



As shown in Figure 4, the overall trend of the Calmar Ratio is very similar to that of the Sharpe Ratio, with the Calmar Ratio tending to increase as the β value increases. Since the negative annual return of the Hang Seng Index affects the Calmar Ratio, i.e. the higher the MDD, the higher the Calmar Ratio, it is difficult to compare with the Calmar Ratio of the Google Trends strategy, so we further compare their MDD.

Based on the results in Figure 5, it can be seen that the Google Trend Strategy has a significantly lower maximum drawdown (MDD) than the benchmark, suggesting that the Google Trends strategy has superior performance in terms of MDD performance.

Figure 5 Comparison of the MDD between Google Trends Strategy and Hang Seng Index



In summary, by comparing the performance of the benchmark and the Google Trends Strategy on each performance indicator, it can be seen that the Google Trends strategy significantly outperforms the benchmark. Although the Google Trends strategy contains only 27 constituents, while the Hang Seng Index contains 76 constituents, the Google Trends strategy still shows superior performance, especially in terms of Sharpe Ratio, MDD and Calmar Ratio. Although the standard deviation of the Google Trends strategy is slightly higher than the benchmark, its excellent overall performance highlights its effectiveness as a market attention diversification strategy. As such, we believe that market attention has an important role to play in portfolio optimization.

5. Conclusion

The aim of this study is to investigate the potential impact of market attention on portfolio optimization, with a particular focus on its role in risk diversification and in improving Sharpe, Maximum Drawdown (MDD) and Calmar ratio.

In this study, we apply stock-specific codes as keywords and use Google Trends to obtain weekly market attention data. Using a rolling window approach, we dynamically adjusted these attention data to optimize portfolio weights and rebalanced on this basis to evaluate their performance in a portfolio optimization framework.

The study systematically compared the Google Trends strategy with the Hang Seng Index benchmark. The results of the analysis show that the Google Trends strategy is effective in reducing risk and outperforms on key performance indicators such as Sharpe Ratio, MDD and Calmar Ratio. Although the risk diversification was slightly lower than the benchmark, mainly due to the relatively higher level of risk associated with the higher returns of the Google Trends strategy, the overall level of risk was not significantly different from the benchmark.

Finally, the results suggest that the introduction of market attention has a significant positive effect on portfolio optimization. In this paper, we have selected 30 constituent stocks of the Hang Seng Index for analysis. Future papers may consider additional constituent stocks to examine the differences in results. And consider whether the results are correlated.

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