

Impact vs Controversial Investing Portfolios: Modeling Returns for Investor Needs

**Raimonda Martinkute-Kauliene¹, Nijole Maknickiene¹,
Viktorija Stasytyte^{2*}**

¹Vilnius Gediminas Technical University, Faculty of Business Management,
Sauletekio av. 11, LT-10223 Vilnius, Lithuania

²Vilnius Gediminas Technical University, Institute of Dynamic Management,
Sauletekio av. 11, LT-10223 Vilnius, Lithuania

e-mail: raimonda.martinkute-kaulienė@vilniustech.lt,

nijole.maknickiene@vilniustech.lt, viktorija.stasytyte@vilniustech.lt

* Corresponding author

Abstract: Impact investing nowadays is one of the popular patterns for making investment decisions when investors consider additional factors besides risk and return. The paper aims to compare the investment results of portfolios constructed using four different attitudes on investment: impact (green and sustainable) investing, problem-solving (healthcare and biopharma research) investing, indifferent (games and entertainment) investing, and controversial or sin (alcohol, tobacco, and gambling) investing. Four methods of portfolio optimization were applied: equal weights method, Monte Carlo simulation, the sequential least squares programming (SLSP), and mean-variance portfolio optimization. 11 different portfolio structures were formed using the data for the 2018-2022 period, starting from completely green and ending with completely controversial portfolio. The results of portfolio testing have shown that in the short-term, both green and sin stocks' portfolios are profitable. Long-term portfolios are generally profitable only in the case of sustainable stocks. Green portfolios are less risky than sin-stocks or diversified portfolios. In terms of methods, the Monte-Carlo portfolios have the lowest risk. The research results can be useful for stock issuers as well as for individual and institutional investors.

Keywords: impact investing, portfolio formation, sustainable stocks, sin stocks, risk, return.

1 Introduction

Investment decisions are closely related to the individual and institutional investor's behavior, investment goals, opportunities, and risk tolerance. There is no doubt that all investors seek returns, but they are not free from emotions when making

decisions. Recurring forest fires, floods, the COVID-19 pandemic, Russia's aggression against Ukraine, and events in Israel and Gaza have further intensified public anxiety about the future and the need to find ways to create a better, more progressive world.

Impact investing emerged as an advanced model of business philanthropy to balance financial and social returns almost 20 years ago. Today, impact investing is one of the greatest success stories in the world of finance: investors have embraced the concept and turned it into a real cultural phenomenon. The best-known impact is associated with sustainability – environmental, social, and governance (ESG) investing [17] [25], which is focused on by most investment funds and investment platforms by providing various sustainability indicators.

Barber et al. [4] have extensively studied the metrics of investment funds that include impact investing in their activities and identified six impact investment categories: environment, minorities and women, poverty, social infrastructure, small and medium enterprise (SME) financing, and regional development. Returning to the motives of investor decision making, it should be noted that many investors are indifferent and categorically separate investment and philanthropy. Some investors invest in health-damaging, socially destructive stocks.

Investors who choose to combine non-property and property returns face the problem of allocating funds in a portfolio without losing or with minimal return loss due to the goals pursued. Known methods of portfolio risk and return optimization remain the main tools for fund allocation and impact in the investment process, but the initial selection of stocks depends largely on the investor.

The aim of the paper is to compare the investment results that investors could obtain using four different attitudes on investment: sustainable companies paying attention not only to the environment but also to social responsibility, leading health care and research companies, gaming and entertainment companies representing indifference, controversial companies from the alcohol, tobacco, and gambling industries. The following research questions can be distinguished:

RQ1: Can impact investing stock portfolios alone deliver higher returns or lower risk compared to other investments in the short or long-term?

RQ2: Is there a portfolio optimization method that results in a higher rate of return (RoR) for impact investing?

RQ3: Does the inclusion of impact investing stocks in a portfolio reduce or increase portfolio risk?

To reach the research aim, the following classic and modern methods of portfolio optimization were applied: Monte Carlo simulation, sequential least squares programming (SLSP), and mean-variance portfolio optimization. The portfolio risk was measured by variance. The stock price data were obtained from finance.yahoo.com. Optimization codes were created using Python.

The structure of the paper is as follows. The first part presents the theoretical background in the field of impact investing, healthcare, and games companies, as well as controversial stocks on the stock market. Next, the methodology of the research is described. The third part describes in detail the performed analysis, results, and comparison of the portfolios constructed. Also, this part employs a short discussion comparing the obtained results with previous findings and highlighting the contributions of the study. The last section presents the conclusions of the conducted research.

1 Literature review

Impact investing has been a steadily growing area in research publications during the last two decades [1]. According to the Clarivate Analytics database, in 2002-2017, there were around 100-960 such publications annually. In 2018, the number of publications on impact investing crossed 1000 a year, and by 2021, it had already exceeded 2000 articles. It was also a topical issue for practical investment decisions [6]. However, not much has been done in investigating particular areas of impact. The best-known types of impact are associated with social, environmental, and health-related outcomes [35]. Responsible investing is becoming very broad, leading to a rise of an ESG investing framework or using an ESG-efficient frontier for portfolio formation. Other areas of impact are also increasingly gaining momentum among investors, such as Cleantech SME financing [38] or human rights [40].

Various issues related to the inclusion of impact stocks in the investment portfolio or to the assessment of the performance of impact stocks or impact investing funds have been described by Brandstetter and Lehner [8], Lo and Zhang [32]. Marti et al. [34] say that sustainable shareholders finance the corporate social responsibility (CSR) activities of sustainable companies by investing in them regardless of lower returns compared to impact-neutral companies. Lee et al. [29] investigated the investment process from the viewpoint of an investor when an investor seeks sustainable goals along with financial return. They demonstrated that since in such a complex situation, the value of the asset is difficult to measure, impact investors often make inefficient decisions, especially when companies are attributed to specific social categories, which, in turn, may contribute to the framing bias. However, it is evident that investors may agree to achieve lower returns in exchange for the possibility of investing in a green project, a climate change initiative, or an environmental protection strategy through the stocks of companies engaged in these activities. However, whether it is lower, the same, or higher portfolio performance may also depend on the period in terms of crisis [22].

Healthcare sector stocks as possible investment assets became very popular during the COVID-19 pandemic. Thus, all recent research on healthcare stocks is mainly

related to COVID-caused changes in financial markets. Healthcare stocks' popularity is explained by the increased need for medical devices, face masks, and other health-related products at the start of the pandemic. Later, the expectation of vaccine creation and various vaccine-related news also contributed to people's positive sentiments about these stocks, increasing their trading volume [26]. More particularly, Jeremiah *et al.* [26] found that media news about vaccination mainly contributes to positive sentiments and encourages people to buy healthcare stocks in Asia. They also decided that healthcare stocks are a good investment portfolio diversification opportunity.

Healthcare stocks have often been analysed together with pharmaceutical and biopharmaceutical sector companies (biopharma stocks), including those conducting research since, in various contexts, the companies belonging to these sectors can overlap. For example, Diaz *et al.* [19] found that only these pharmaceutical companies that developed vaccines experienced higher returns during COVID-19. Mittal and Sharma [36] aimed to determine whether the COVID-19 pandemic impacted stock returns in these sectors. These stocks received positive abnormal returns in the first months after the COVID-19 outbreak. Also, the Bombay Stock Exchange (BSE) Healthcare index has grown by 14 percent. However, these results do not show a big picture since only a small period at the beginning of the pandemic was analysed. Ho *et al.* [23] also analysed both the healthcare and pharmaceutical sectors but slightly from another point of view. They found out that firm age and size matters. Young and small firms are more vulnerable to medical reforms and do not show high returns during the pandemic since investors usually trust older and larger companies.

The video games industry is a continuously evolving, innovative, and technologically driven industry due to its specific operation and original value creation chain. Initially developed for entertainment, nowadays, games also can be a tool for education or self-expression. Moreover, innovative solutions, primarily developed in the games industry, often become adopted in other fields, such as TV platforms or social media [30]. The video game industry mainly consists of such actors as video game developers, producers, and distributors, to name a few. From the academic point of view, the video games industry has been analysed in various aspects, such as technological [27], cultural [45] [15], psychological [28] [5], and education [49]. Video game companies' stock returns have been analysed by Piñeiro-Chousa *et al.* [42], though, in the context of COVID-19, since the pandemic and lock-down contributed to video games' popularity. The portfolio of video game companies' stocks was constructed by Mäkinen [34]. Cui and Zhu [16] used the Modern Portfolio Theory – the minimum risk and maximum expected return approaches – to form portfolios from four companies in this industry. Both portfolios were profitable, especially the latter. However, the authors admitted that these abnormal positive returns were achieved due to COVID-19.

The sin stock research area started developing in the wake of socially responsible investing, when conforming to the stated social norms became a factor investors

care for. Actually, sin stock studies were started by Fabozzi et al. [21], who determined that the portfolio of controversially treated stocks can provide a 19% return, and Hong and Kacperczyk [24], who found that large institutions hold fewer sin stocks, which, in turn, impacts the cost of capital of the latter. Later, sin stocks-related research has evolved in various directions. The discovery of sin stocks' high performance was still on the research agenda. Often, the researchers concentrated on comparing controversial vs socially responsible or neutral stocks. Thus, Wu and Xia [51] compared sin and ethical stocks in terms of their spillover effect, while Rezaeian and Racine [43] compared sin and non-sin stocks according to their risk (measured by beta, idiosyncratic risk, and total volatility), and Cheung and Lam [12] and Colonnello et al. [13] compared sin and non-sin companies according to both expected return and volatility from the standpoint of investor. Some research is devoted to excluding sin stocks from the investment portfolio [2] [7] as socially unfair or not conforming enough to social norms.

Regarding the particular areas of controversial impact, the greatest attention in academic literature has been paid to the traditional fields of sin stocks, such as alcohol, tobacco, gambling, and sometimes weapons [9] [43]. Sagbakken and Zhang [44] included carbon-intensive sectors in their analysis, such as oil and gas production, as well as metals' mining industry stocks. However, Trinks and Scholten [47] added even more areas to the list, some of which were not widely recognized as controversial, such as animal testing, contraceptives, or genetic engineering.

Unexpectedly, the performance of controversial stocks has been measured by the indicators traditionally attributed to positive impact-providing stocks. ESG, sustainability, or CSR performance of sin stocks from various points of view, along with the broad impact of this performance, was researched by Paradis and Schiehl [39], Cayón and Gutierrez [11] and Wong and Zhang [50]. There are also not so frequent topics related to controversially perceived companies, such as assessing the efficiency of sin stock indices [3], or investor sentiment impact on sin stock returns [31].

In our research, we will analyse four different attitudes on investment: sustainable companies, including green and socially responsible, health care and biopharma research companies, indifferently treated stocks from the gaming and entertainment industry, and traditional sin stocks, known as *Triumvirate of Sin* – belonging to alcohol, tobacco, and gambling sectors. All four types of stocks will be analysed together, aiming to assess their potential attractiveness for investors with broad investment goals.

2 Methodology

The cycle of real investment in the stock market usually consists of stock selection and analysis, portfolio formation, trade execution, and investment performance evaluation. In our research, substantial attention is given to the stock selection step since investors' attitudes are expressed through the activity of companies selected for investment. The key innovation of the elaborated idea lies in the comparison of impact and controversial investment assets, complementing them with the so-called problem-solving (healthcare) and indifference (gaming industry) stocks. As a result, four separate blocks of shares are formed (Figure 1) for future analysis and inclusion in the portfolio.

Next, the methodology of the investment process is described according to four previously defined steps.

Step 1. Stock selection and analysis. The choice of stocks is influenced by the analysis of scientific literature, possible data, market analysis and the analysis of the indicators of the joint stock companies themselves (how they correspond to the chosen attitudes on investments). The period we are testing (years 2022-2024) is characterized by greater public attention to health after the COVID-19 pandemic and attention to public responsibility for wars and climate change. After selecting groups of shares according to the investor's attitude to the impact of investment (Figure 1), the indicators of joint-stock companies were evaluated.

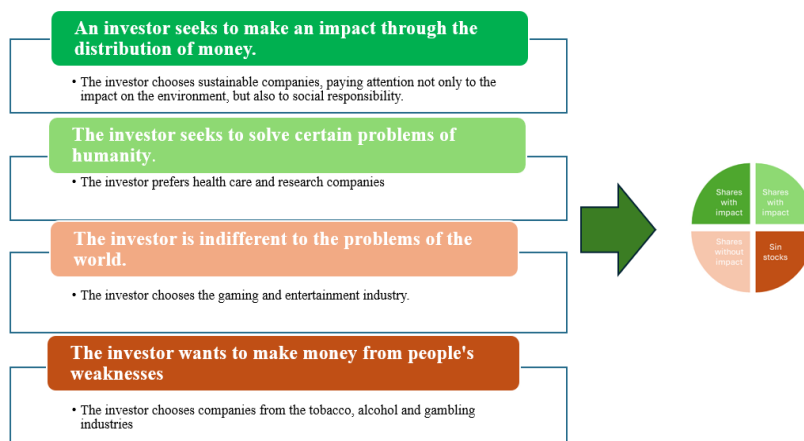


Figure 1

The scheme of selection of shares

The selection of sustainable (green) companies was based on the highest ranking in *Corporate Knights' Global 100 Index*, which is committed not only to

environmental sustainability but also to the well-being of employees, gender diversity, and more [14].

The stocks of healthcare companies were selected based on their critical mission to help people regain their health: biopharmaceutical companies that develop, manufacture, and distribute drugs for serious diseases, genetic engineering companies, orthopedic product companies, and companies that develop and manufacture medical technology and modern surgical equipment. Gaming companies were selected from the *Global Electronic Gaming & Multimedia Index* [37]. The activity of these companies is based on the creation and distribution of video and mobile, online, PC, and console games. Digital and interactive entertainment solutions and services are the main products of such companies.

The selection of controversial companies was based on the type of activity, from the alcohol, tobacco, and gambling industries (*The Triumvirate of Sin*), preferring higher capitalization and popularity. This group was chosen as a complete alternative to impact investment.

Step 2. Portfolio formation. Python code created seven portfolios using 01/03/2018-01/03/2021 historical data and seven portfolios using 01/03/2019-01/03/2022 historical data. Modern (SLSP) and classical (Monte-Carlo) methods of portfolio optimization created two versions of portfolios – the minimal risk (volatility) and maximum Sharpe ratio portfolios. As a result, the following methods of portfolio optimization were used:

- Equal weight portfolio without optimization;
- The Monte Carlo simulation – 2 portfolios;
- The sequential least squares programming (SLSP) – 2 portfolios;
- Mean-Variance – 2 portfolios with 15% and 30% expected return, respectively.

All fourteen formed portfolios were tested for a short period of one year and a long investment period of 2 and 3 years by taking new data not used for portfolio formation. The detailed periods of portfolio testing, corresponding to the periods of portfolio formation, are presented in Table 1.

Table 1
Periods of portfolio formation and testing

Portfolio formation period	Duration of the formation period	Portfolio testing period	Duration of the testing period
01/03/2018-01/03/2021	3 years	01/03/2021 – 01/03/2022	1 year
		01/03/2021 – 01/03/2023	2 years
		01/03/2021 – 01/03/2024	3 years
01/03/2019-01/03/2022	3 years	01/03/2022 – 01/03/2023	1 year

The use of different optimization methods, different data sets for portfolio construction and testing, and short-term as well as long-term investment periods reduces the probability of overestimating random success and allows us to expect a more precise observation of regularities.

Step 3. Trade execution. The constructed portfolios have not been traded on a real stock market. Their structure was fixed on the final date of the formation period (either 01/03/2021 or 01/03/2022) and has not been changed during the whole testing period. The RoR and risk of portfolios were calculated at the end date of the testing period.

Step 4. Investment performance evaluation. During this step, portfolios with and without impact were modeled. An investor who wants to make an impact by allocating cash must balance his needs and the pursuit of profit. In order to determine the optimal proportions of stocks with and without impact, we modeled the test data by including different amounts of stocks of the four selected approaches, as shown in Figure 2. The first two portfolios consist only of stocks "with impact", the following seven have successively lower impact, and the last two are portfolios without any impact.

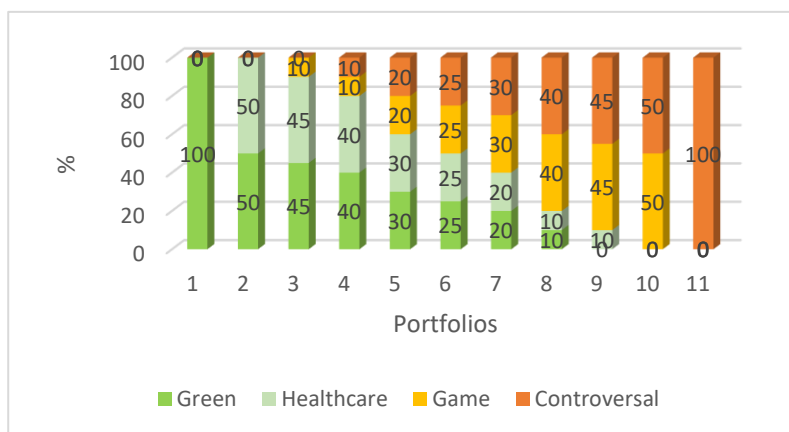


Figure 2

Proportion of assets with and without impact in the proposed portfolios

The results of the testing period fully meet the conditions of investing in uncertainty. The dates for the portfolios were chosen to be March 1, 2021, and March 1, 2022, because around that time, companies report for the previous year, and investors review companies' financial and performance indicators and evaluate and forecast their future investments. The tested data, not included in the formation of portfolios, does not influence the selection of stocks and simulates the actual results of short and long investments. The risk of all 11 portfolios was evaluated by calculation of variance.

3 Results and discussion

The four investor attitudes chosen for the empirical study are reflected in the selection of stocks. 10+10 stocks have been selected, which reflect the investor's need to make the world more sustainable and help cure patients with serious diseases. As an alternative for comparison, 10 stocks were selected, reflecting an indifferent attitude towards world problems, and 10 stocks that profit from people's weaknesses. Four groups of stocks (Table 2) form the basis for constructing different portfolios.

Table 2
Shares selected for portfolio formation

Green companies	Health care companies	Games companies	Controversial companies
Schnitzer Steel Industries	CRISPR Therapeutics AG	Activision Blizzard, Inc.	Philip Morris International Inc.
Vestas Wind Systems	Athira Pharma, Inc.	NetEase, Inc.	Altria Group, Inc.
Brambles BXB.AX	AC Immune SA	Nintendo Co. Ltd.	Vector Group Ltd.
Brookfield Renewable Partners	Annovis Bio, Inc	Electronic Arts Inc.	Universal Corporation
Autodesk ADSK	United Therapeutics Corporation	Take-Two Interactive Software, Inc.	Turning Point Brands, Inc.
Stantec (joint position)	McKesson Corporation	NEXON Co., Ltd.	Churchill Downs Incorporated
Schneider Electric (joint position)	Kancera AB	Sega Sammy Holdings Inc.	International Game Technology
Chr. Hansen Holding A/S	Vertex Pharmaceuticals Incorporated	Capcom Co., Ltd.	Light & Wonder, Inc.
Taiwan High Speed Rail Corporation	Stryker Corporation	Square Enix Holdings Co., Ltd.	Everi Holdings Inc.
Dassault Systèmes SE	Amgen Inc.	Paradox Interactive AB	Accel Entertainment, Inc.

For each set of shares listed in Table 2, we create different portfolios from the selected four investment approaches using Python code: equal weight, Monte Carlo method, SLSP method, and mean-variance method, using minimum risk and maximum Sharpe ratio options. Two historical stock price data sets are used to simulate real investor choices: 01/03/2018-01/03/2021 and 01/03/2019-01/03/2022. The results obtained by the distribution of funds by various methods were tested in the short period of one year from March 1, 2021, and from March 1, 2022, and in the long period of 2 and 3 years from March 1, 2021. Rate of return (RoR) results are presented in Table 3.

Table 3 shows that investing from March 1, 2021, to March 1, 2022, was more profitable than a year later, and investing in a long period of 2-3 years was more successful than in a short period of one year. Considering different portfolio

construction methods, all portfolios that achieved maximum Sharpe were more successful than portfolios with minimum volatility.

Table 3
Rate of return of short and long-time investment for four types of stock portfolios

One-year investment from March 1, 2021 and 2022									
Method	Portfolio	Green portfolios closed		Healthcare portfolios closed		Games portfolios closed		Controversial portfolios closed	
	Investment year	2022	2023	2022	2023	2022	2023	2022	2023
Equal	Equal weight	2.64%	-2.29%	21.00%	-3.05%	-8.50%	-0.37%	11.59%	-5.63%
Monte Carlo	Portfolio with minimum volatility:	-2.57%	-13.98%	18.10%	13.36%	11.76%	0.73%	21.36%	-3.90%
SLSP	Portfolio with minimum volatility:	3.77%	-18.02%	17.55%	16.28%	12.83%	-0.75%	17.36%	-3.01%
Mean-Variance	Efficient portfolio for a 15% return level	25.84%	-27.86%	25.27%	22.66%	20.23%	-1.91%	25.59%	14.50%
Monte Carlo	Portfolio with maximum Sharpe ratio:	15.65%	-5.64%	24.36%	21.11%	16.10%	7.81%	31.69%	12.08%
SLSP	Portfolio with maximum Sharpe ratio:	11.09%	-7.08%	-5.19%	24.27%	-6.64%	2.12%	15.09%	-8.52%
Mean-Variance	Efficient portfolio for a 30% return level	20.39%	-0.68%	14.78%	13.58%	-7.95%	2.52%	16.85%	19.55%
2-3 years investment from March 1, 2021									
Method	Portfolio	Green portfolios		Healthcare portfolios		Games portfolios		Controversial portfolios	
	Investment time	2 years	3 years	2 years	3 years	2 years	3 years	2 years	3 years
Equal	Equal weight	0.22%	13.61%	14.51%	4.58%	-8.31%	-4.46%	6.23%	6.14%
Monte Carlo	Portfolio with minimum volatility:	17.82%	-16.86%	16.47%	2.31%	10.38%	-4.19%	17.79%	10.53%
SLSP	Portfolio with minimum volatility:	15.77%	-21.41%	18.82%	3.03%	18.22%	-7.86%	12.23%	7.61%
Mean-Variance	Efficient portfolio for a 15% return level	-5.27%	-2.31%	26.70%	5.43%	17.41%	-9.30%	13.62%	17.83%
Monte Carlo	Portfolio with maximum Sharpe ratio:	21.89%	49.29%	20.26%	14.36%	15.61%	0.20%	17.70%	54.06%
SLSP	Portfolio with maximum Sharpe ratio:	15.60%	31.74%	-4.45%	9.46%	-5.90%	0.82%	11.57%	32.61%
Mean-Variance	Efficient portfolio for a 30% return level	43.15%	101.53%	14.37%	7.59%	-7.89%	-2.25%	10.56%	25.64%

Having the RoR results of various portfolios, we can model different investor decisions according to the scheme presented in Figure 2. We have 11 options for the investor, from completely sustainable, impactful portfolios (1 and 2) to completely rejecting any positive impact (10) or even harming human life (11). The positive effect decreases consistently in portfolios 3-9.

Using the RoR data presented in Table 3, we can assess the investment performance of different investor choices that include sustainable stocks, impact stocks, games

stocks, or sin stocks. Figures 3a-3d present graphs reflecting changes in investment RoR when taking different proportions of stock groups. Looking at portfolios for a short period of one year shows that both extreme choices (sustainable and sin stocks) have exceptionally positive RoR. However, when making proportions, RoR consistently increases with an increasing share of non-sustainable and sin stocks. The two-year investment results already show that two portfolios (the Monte Carlo and SLSP) have the opposite trend. In the three-year investment (Figure 3d), it can be seen that sustainable and positive-impact investing has a positive impact on RoR.

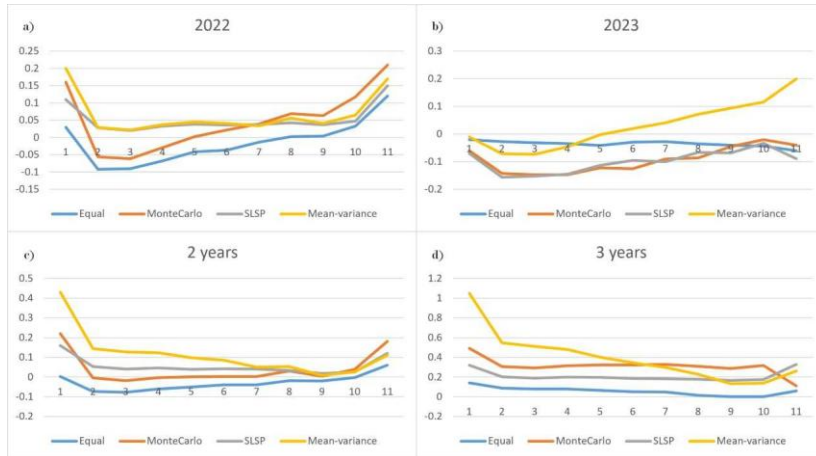


Figure 3

a) RoR of 11 portfolios after 1-year investment (2022); b) RoR of 11 portfolios after 1-year investment (2023); c) RoR of 11 portfolios after 2-year investment; d) RoR of 11 portfolios after 3-year investment

The risk assessment for all 11 differently balanced portfolios (as shown in Figure 2) is presented in Table 4, with volatility calculation. The low volatility corresponding to the first quartile of all results is marked in green. The 3rd quartile volatility corresponding to higher risk is marked in brown.

The table shows that the risk increases as the investment period increases. It is also important to note that more sustainable and positive impact portfolios are inherently less risky.

To determine the particular portfolios favourable for investors in terms of both return and risk, all portfolios' return and risk values are plotted graphically to form a feasible set of portfolios and determine the efficient frontier. Three available sets of portfolios are presented according to the time period in Figure 4. As can be seen from Figure 4a, the efficient frontier of one-year portfolios virtually consists of only two portfolios: portfolio 1 (consisting of 100% green stocks), constructed using the Monte Carlo model, and portfolio 11 (consisting of 100% sin stocks), constructed using Monte Carlo simulation. One particular portfolio should be selected

considering the investor's utility function. Figure 4b shows that among 2-year portfolios, only portfolio 1, the green portfolio, is efficient, which is constructed using either Monte Carlo or Mean-variance methods. And finally, Figure 4c also shows the results in favour of portfolio 1, constructed using both methods previously mentioned.

Table 4

Risk valuation (%) of all balanced portfolios. Median 4.33%, less than Q1=3.47 % marked green, more than Q3 = 5.42 % - marked brown

Time	Portfolios	1	2	3	4	5	6	7	8	9	10	11
2022	Equal	2.88	3.78	3.51	3.44	3.11	2.94	2.77	2.44	2.36	2.10	3.12
	Monte Carlo	1.41	2.12	2.46	2.58	3.03	3.26	3.49	3.94	4.24	4.40	3.30
	SLSP	1.78	3.12	3.51	3.52	3.92	4.13	4.33	4.73	5.06	5.13	3.23
	Mean-Variance	4.33	3.34	3.47	3.53	3.72	3.82	3.92	4.11	4.10	4.30	3.94
2023	Equal	2.88	5.22	4.96	5.27	5.32	5.34	5.36	5.41	5.67	5.46	8.28
	Monte Carlo	3.29	3.79	3.93	4.32	4.86	5.12	5.39	5.93	6.24	6.46	7.73
	SLSP	3.09	4.57	5.03	6.03	7.49	8.22	8.95	10.41	11.29	11.87	14.56
	Mean-Variance	2.78	3.42	3.95	5.06	6.70	7.52	8.35	9.99	10.87	11.63	14.56
2 years	Equal	5.40	5.64	5.26	5.26	4.87	4.68	4.49	4.10	3.94	3.72	5.64
	Monte Carlo	1.35	2.15	2.42	2.74	3.34	3.64	3.93	4.53	4.90	5.12	5.35
	SLSP	1.78	3.12	3.51	3.52	3.92	4.13	4.33	4.73	5.06	5.13	3.23
	Mean-Variance	6.53	4.94	5.73	6.55	8.16	8.97	9.77	11.38	12.03	13.00	13.07
3 years	Equal	3.72	5.70	5.36	5.30	4.91	4.71	4.51	4.12	4.12	3.72	5.16
	Monte Carlo	1.17	1.95	2.15	2.49	3.04	3.31	3.58	4.13	4.48	4.68	5.39
	SLSP	2.13	2.96	3.12	3.39	3.83	4.05	4.26	4.70	5.00	5.13	5.68
	Mean-Variance	3.56	3.10	3.92	5.75	8.40	9.72	11.04	13.69	14.97	16.34	21.39

As a result, it can be seen that only portfolios formed of pure green stocks or pure controversial stocks can be efficient in terms of their risk and return. Including healthcare or games stocks in the portfolio structure does not add any additional value from the pure financial viewpoint. Also, it was proven that in the impact-related portfolio formation process, SLSP and equal weight portfolio construction methods are less effective than Monte Carlo and Mean-variance models. However, since investors who care about companies' impact on society may construct portfolios not only considering risk and return properties but also pay more attention to the broader impact of assets, they do not necessarily make their investment decisions based on classical characteristics. The investor can find a suitable portfolio below the efficient frontier, having the required additional characteristics. The formation of such two-dimensional or three-dimensional efficient frontiers

using additional factors is already presented in literature but very fragmentally [41] [10]. However, given the growing prominence of impact investing and concerns around the ESG performance of companies, the need for research in this field will continue to increase. Thus, it can be pointed out as a necessary area for future research.

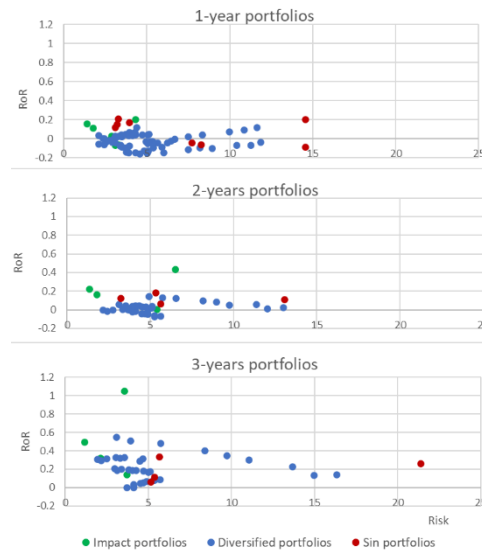


Figure 4

Feasible sets of portfolios: a) 1-year testing period, b) 2-years testing period, c) 3-years testing period

Further, the answers to the research questions raised in the introduction can be discussed. The RQ1 can be answered positively for both short-term and long-term periods since pure impact portfolios were considered efficient according to their risk-return framework in Figure 4. However, it is worth noting that one purely controversial portfolio was also efficient in the short-term period. Considering RQ2, all the applied optimization methods showed high returns for impact investing stocks, but it depended on the minimizing and maximizing criteria, as well as on the time period of investment testing. For example, the equal weight method could be used only for a 3-year investment. Also, the Monte Carlo and SLSP methods proved to be effective only in the case of maximum Sharpe ratio but not in the case of minimum volatility. Finally, RQ3 can also be answered positively since lower risk is demonstrated by the portfolios having more impact stocks. This trend can be clearly seen from Table 4 (less risky portfolios are marked in green) and in Figure 4, where all impact portfolios (coloured in green) concentrate on the left side, meaning the lower risk.

When we analyse previous studies of portfolio construction using impact stocks, Dai's research [18] can be taken into account. Based on the Chinese case, it was proven that including ESG factors in portfolio selection might increase risk-adjusted return and improve diversification. These findings, in principle, comply

with our results, as our three performed testing cases (1 year, 2 years, and 3 years) resulted in the pure green portfolio being the most efficient (with the exception of one sin portfolio during a one-year period, which was equally efficient to the green one). However, the difference here is that the study of Dai [18] evaluated portfolios of stock indices but not separate stocks. Some passed studies also demonstrated the favourable performance on the stock market and risk-adjusted return of stocks screened for sustainability criteria [21]. However, their results do not take into account the effects of the COVID-19 pandemic, recent geopolitical crises, and ever-changing perception of ESG criteria. Thus, our study uses the most recent data and adds some fresh insight into the topic of impact investing.

Healthcare and biopharma research companies have also been considered for portfolio formation among researchers. Sun et al. [46] formed a portfolio of pharmaceutical companies using the equal-weighted model and Monte Carlo simulation, where minimum variance and maximum Sharpe ratio portfolios were determined. The Monte Carlo portfolio showed better results compared to the equal-weighted model. We can say that the results of Sun et al. [46] are neither consistent nor inconsistent with our study because the conclusion depends on the time period.

Summarizing the above presented research results in combination with previous literature findings, the precise contribution of the paper to the area of impact investing can be determined. The four different attitudes on investment have never been analysed together from the investor's perspective, considering not only risk and return but also emotional decision making possibilities. Moreover, the originality of the research also lies in the approach toward the four types of companies analysed. We employ the perspective of the impact on society, which may be positive, negative, or indifferent. However, this research differs from the traditional impact investing papers, ESG, and CSR-related studies because the channel through which this impact is realized goes beyond environmental, social, and governance issues. Finally, the innovative stock selection stage is combined with a wide range of methods for portfolio construction, which have not been used together in this particular context.

Conclusions

The paper aimed to construct and compare portfolios made of four different categories of stocks according to their impact on society: impact (green and sustainable) stocks, problem-solving (healthcare and biopharma research) stocks, indifferent (games and entertainment) stocks, and controversial, or sin (alcohol, tobacco, and gambling) stocks. In each category, 10 companies were selected. Using the historical data from 01/03/2018 - 01/03/2021 and 01/03/2019 - 01/03/2022 periods for portfolio formation and applying four different methods with their varying objectives, seven different return forecasts were formed. Combining these results with 11 different portfolio structures, starting from completely green and ending with completely controversial portfolio, the return and risk results in the selected short-term and long-term testing periods have been

presented. It was found that in the short-term, both green and sin stocks' portfolios are profitable, with lower profit in the case of the most diversified structure. Long-term portfolios are generally profitable only in the case of sustainable stocks, with a 3-year period providing a higher return when compared to a 2-year period. Pure controversial portfolios have very low but positive returns in the long run. While analysing risk indicators, a conclusion can be made that long-term portfolios generally are riskier than short-term. Though this result is not in line with the classical investment theory provisions, here, the reason could be exactly the specifics of the social impact of the analysed stocks. Also, green portfolios are less risky than sin-stocks or diversified portfolios. In terms of methods, the Monte-Carlo portfolios have the lowest risk, while Mean-variance portfolios are the riskiest.

The paper has both theoretical and practical relevance. To the best of our knowledge, this is the first study to include the four types of impact-making stocks, including the negative impact (controversial stocks). Such a point of view broadens the academic discussion and reflects the contemporary situation in the financial market, where, along with the boosting prevalence of ESG or impact stocks, we cannot deny the existence of controversial or indifferent stocks and their important role in the financial market. Also, the performed analysis enriches academic research on portfolio formation since we apply four different portfolio formation methods, which, combined with maximizing or minimizing objectives or setting portfolio return levels, form seven different portfolio forecast trends. Thus, it allows researchers to broadly analyse a universe of investment possibilities and make relevant insights.

Practically, our research can be useful for companies – stock issuers, as well as for individual and institutional investors. We can see that the portfolios formed by applying the controversial stocks or using their combination with game stocks can generally be of particular interest only to short-term investors. Keeping this in mind, and intending to attract long-term investment funds, the issuers of gaming and controversial stocks should make certain strategic decisions to counterbalance their negative impact on society. Concerning the implications for investors, this is a very extensive decision making framework that perfectly fills the needs of investors with an analytical mindset. Our approach offers a pool of portfolios with their structures and obtained return and risk indicators during the different testing periods. It is a great analytical and educational tool that can assist investors in making more informed investment decisions.

Some limitations of the research could be distinguished, inducing the respective future research directions. Since the data period used for portfolio formation covers 2018-2022 years, it includes the COVID-19 period. But the portfolio testing has been performed largely during the post-COVID period. It could have altered the testing results. However, the estimations using stock market data during the pandemic, which was generally more volatile, additionally strengthens the results. In the future, it is worth conducting similar research, taking the post-COVID period data for both portfolio formation and testing to avoid possible bias in estimations

and assessment of results. Also, the obtained results in terms of portfolio risk and return were neither compared to a market index nor to the “ordinary” shares, which do not belong to any of the four categories. This happened mainly because the used stocks were not taken from one particular stock index, which complicated the process of comparison. So, in the future, it is worth selecting the closest market index and comparing the performance of the constructed portfolios with the market average.

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