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An Integrated Approach on MSMEs Financial Literacy

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ABSTRACT

Purpose:
The main objective of this paper is to suggest an integrated approach of assessing the level of financial literacy of MSMEs, combining quantitative data derived by the use of the OECD/INFE (2019) questionnaire, and qualitative data via designing focus groups to discuss the survey results with various stakeholders and get policy recommendations.

Design/methodology/approach:
We apply a two-stage methodology; we first use the specifically designed OECD/INFE (2019) questionnaire, and we second apply qualitative focus-group analysis methodology, where we create groups of stakeholders to discuss MSMEs financial literacy.

Findings:
Stage 1 results show that the financial literacy score of Greek MSME owners is 60.23%, very close to the adult population OECD (2020) percentage. In stage 2, we discuss the scores and survey results with stakeholders in focus groups and we get specific recommendations in the MSMEs financial literacy field, from an MSMEs policy perspective.

Research limitations/implications:
The main limitation of this study is the small sample of MSME owners that participated in the first stage of our methodological approach. The main practical implication of this paper is that the MSMEs stakeholders' bodies can offer useful insights in the MSMEs financial literacy field.

Originality/value:
This study contributes to the field of MSMEs financial literacy (FL) by suggesting an integrated approach in measuring the financial theory of MSMEs, by including both quantitative and qualitative data. We believe that, by suggesting the inclusion of qualitative data derived from the MSMEs stakeholders' bodies, to complement the quantitative outcome via the application of the OECD structured questionnaire, we can reach better conclusions regarding the MSMEs FL field.

1. Introduction

Financial literacy is defined as the "*ability to read, analyze, manage and communicate about the personal financial conditions that affect material well- being*" (Vitt et al., 2000). Focusing on the specific financial concepts under financial literacy, most definitions include aspects such as money basics, borrowing, investing and protecting resources (Huston, 2010). Governments and international organizations have recognized the importance of financial literacy since the beginning of the 20th century. Probably the first action for the improvement of financial literacy came from the USA with the Smith-Lever Act (USDA) in 1914, which developed university programs for research and teaching the public "useful and practical information" about a range of topics, including personal finance. In recent years, many developed countries have developed strategies and programs for the financial literacy of high school students and adults. The OECD has been particularly active in the field, developing a series of initiatives, starting with the Financial Education Project in 2003[1], followed by a publication of best practices in 2005[2], while in 2008 the Organization created the

[1]https://www.oecd.org/finance/financial-education/oecdfinancialeducationprojectbackgroundandimplementation.htm
[2]https://www.oecd.org/finance/financial-education/35108560.pdf

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International Network on Financial Education (OECD/INFE) which aims at collecting and sharing data and good practices, developing methodologies and policy instruments and promoting their implementation and monitoring[3].

Financial literacy is a broad field that expands from primary school pupils to pensioners, and from self-employed to micro and small -sized entrepreneurs (MSMEs)[4]. Studies have shown that financial literacy positively affects their performance and overall strategy and is essential for their survival (Davidson, 2004; Wise 2013; Allgood & Walstad, 2016). In this context, the World Bank (2014) reported that financial literacy could help MSMEs, and especially those in the informal sector, overcome their financial constraints and address their financial exclusion[5], while the OECD (2017)[6] pointed out that we should identify the needs of micro and small entrepreneurs in financial competency and collect evidence on their financial literacy. It should be highlighted that the particular area of MSMEs is of great importance for all economies, since they consist of the majority of enterprises worldwide, contribute significantly to employment and their effectiveness is rather crucial for inclusive growth (Ioannidis & Giakoulas, 2023).

Although the importance of financial literacy is undisputed in a series of fields in the economic life of various stakeholders, the respective research level on the specific subfield of micro and small entrepreneurs and its links with relative fields in their economic activity is very fragmented. It is only very recently that this particular area of the financial literacy of micro and small entrepreneurs seems to have started attracting the interest of the academic community, as evidenced by the recent works of Anshika & Singla (2022) and Grana-Alvarez et al. (2022) who both offer a systematic literature review in this field. Both papers highlight the fragmented research efforts, particularly in the area of measuring the financial literacy of micro and small entrepreneurs. To date, perhaps the most coherent effort to measure MSMEs[7] financial literacy is that of OECD/INFE (2019), which constructed a detailed questionnaire that splits financial literacy into three dimensions, each containing a number of entrepreneurship-related questions, developed to measure financial literacy aspects. However, the OECD/INFE questionnaire, despite being the broader and most conclusive available questionnaire to date, still provides a relatively "narrow" scope of the financial literacy field in question, since it measures financial literacy based on the small entrepreneurs' input and from their perspectives, missing important qualitative aspects in a broader stakeholders' context. It thus fails to offer an integrated approach of the MSMEs financial literacy field in question.

This is the main idea behind the paper. Namely to suggest an integrated approach of assessing the level of financial literacy of MSMEs, combining quantitative data derived by the use of the OECD/INFE (2019) questionnaire, and qualitative data via designing focus groups to discuss the survey results with various stakeholders and get policy recommendations. In this context, we apply a respective two-stage methodological approach. In stage one, we apply the specifically designed OECD/INFE (2019) questionnaire, as the most effective available tool to measure MSMEs financial literacy to date. In stage two, we apply qualitative focus-group analysis methodology, where we create groups of stakeholders to discuss MSMEs financial literacy. This way, we gain insights from both the focus instrument (MSMEs) and the general environment (stakeholder institutions), which allows us to shape a more integrated picture of the financial literacy issue in question. Our dataset of MSMEs respondents is small, and this is the main limitation of our paper. However, the primary objective of this paper is to suggest an integrated approach of assessing the level of financial literacy of MSMEs, and not to focus on the actual numeric results derived; we believe that the approach we suggest triggers a new academic route in the MSMEs financial literacy context.

The remainder of the paper is as follows. Section 2 defines financial literacy and discusses the challenging field of measuring financial literacy in general, gradually focusing on MSMEs, and concluding that the OECD/INFE (2019) questionnaire even if being, to date, the best tool available to use, should be complemented with qualitative approaches as well, to get a more integrated picture of the field in question. Section 3 reviews the academic literature in the MSMEs financial literacy field. Section 4 discusses the methodology, Section 5 presents the results, while Section 6 concludes the paper.

2. MSMEs Financial literacy; definition and measurement

There are plenty of conceptual definitions of financial literacy that describe the abilities, attitudes and financial concepts that a financial literate person should possess. On the abilities and attitudes, most definitions include elements such as the knowledge of specific financial concepts, being able to communicate about these concepts, the ability to manage personal finances, the ability to make appropriate financial decisions and planning for the future financial needs (Remund, 2010). In this context, as also mentioned above, one of the most widely accepted definitions

[3]https://www.oecd.org/financial/education/oecd-international-network-on-financial-education.htm

[4]In this paper, we use the MSMEs abbreviation for micro and small enterprises and the SMEs abbreviation for micro, small and medium-sized enterprises.

[5]ACCA (January 2014) – Financial Education for Entrepreneurs: What Next?

[6]https://www.oecd-ilibrary.org/docserver/bb2cd70c-en.pdf?expires=1648078596&id=id&accname=guest&checksum=26F04A0392BA8AAA864C8FB7D1E566C2

[7]We use the terms "MSMEs financial literacy" and "micro and small entrepreneurs' financial literacy" interchangeably. The focus of the study is on the individual, the entrepreneur him/herself.

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is the "*ability to read, analyze, manage and communicate about the personal financial conditions that affect material well- being*" (Vitt et al., 2000)[8].

Another definition is that of OECD which defines financial literacy as "the process by which financial consumers/investors improve their understanding of financial products, concepts and risks and, through information, instruction and/or objective advice, develop the skills and confidence to become more aware of financial risks and opportunities, to make informed choices, to know where to go for help and to take other effective actions to improve their financial well-being" (OECD, 2005).

As regards the definition of financial literacy of micro and small enterprises, looking at the literature for a workable definition, probably the most concrete and inclusive is of OECD/INFE who define financial literacy of MSMEs as "the combination of awareness, knowledge, skills, attitudes and behaviour that a potential entrepreneur or an owner or manager of a micro, small or medium-sized enterprise should have in order to make effective financial decisions to start a business, run a business, and ultimately ensure its sustainability and growth" (OECD, 2018)[9]

Measuring financial literacy is not an easy endeavour. Lusardi & Mitchell (2011) note that "*while it is important to assess how financially literate people are, in practice it is difficult to explore how people process economic information and make informed decisions about household finances*". In this respect, there have been many attempts for the measurement of financial literacy through converting the concepts described above into measurable criteria. These criteria are used to assess the level of financial literacy of a given population sample through surveys.

There are already several survey-based tools that focus on measuring the economic and financial literacy in various stakeholder subfields. From the American Developmental Economic Education Program (DEEP) context (Soper & Brenneke, 1981) to the National Endowment for Financial Education (NEFE) program (Danes, 2004), numerous studies have been constantly evaluating the levels of financial literacy for high school students (Braunstein & Welch, 2002; Mandell, 2008). There are much more studies conducted for adults, where the impact of financial literacy on adults' life is measured (Lusardi & Mitchell, 2011; Fornero & Monticone, 2011; Bucher-Koenen & Lusardi, 2011; Sekita, 2011).

There is also a number of studies to compare financial literacy, mainly on different categories of adults, across countries. For example, the World Bank has deployed a series of comparable surveys since 2006 in developed and developing countries concluding that financial literacy is significantly lower in the later (Xu & Zia, 2012), while another wide survey has been that of Standard and Poor's which measured the financial literacy of 150.000 adults in 140 countries (Klapper et al., 2014). In general, the financial literacy field for adults and students is indeed relatively exhaustive.

However, the picture is more blur when it comes to measuring financial literacy for MSMEs; it seems that the overall field of financial literacy and MSMEs is rather fragmented, consisting of individual research efforts with different approaches that do not provide a coherent picture of an overall financial literacy level. Some of these efforts are described in the paragraphs that follow.

Brown et al. (2006) conducted a survey on the financial literacy of 147 new business owners in UK. The questionnaire included a quite wide range of concepts such as financial investments, prior seeking of financial advice or educational programs and their perceptions on their perception and confidence on their level of financial skills. Sage (2012) conducted a survey regarding the financial literacy of 300 SME owners in Canada. They focused on their overall perceptions, knowledge, and habits on the concepts of financial management, resources, and compliance. Pearl & Eileen (2014) focused on researching the financial literacy of startups in the USA. They addressed a questionnaire in 14 small firms which was practically a test on their level of their financial understanding as part of the financial analysis of the firms. Fatoki (2014), deployed a survey on the level of financial literacy of micro enterprises owners in Johannesburg – South Africa. The survey included simple questions of every day financial practices such as financial planning, bookkeeping, funding sources, understanding of business terminology, use of technology and business insurance. Plakalović (2015) surveyed the financial literacy of 51 business owners/managers in Banjaluka and East Sarajevo regions. The survey included questions on everyday financial issues such as the estimation of their profitability, the usage of financial reports and financial analysis etc.

Conclusively, there are several studies investigating the financial literacy of MSMEs and providing useful insights, but they do not have a common ground on the aspects of financial literacy they investigate. Anshika & Singla (2022) cite more than 20 studies, and Grana-Alvarez et al. (2022) cite 71 studies in their systematic literature reviews regarding SMEs financial literacy and describe the broad spectrum of parameters and conceptualization approaches that researchers use in their studies.

In this context, probably the most coherent and inclusive survey of measuring the level of financial literacy of small entrepreneurs to date is that of OECD/INFE (2019). The survey provides a common framework for surveying and measuring the financial literacy of MSMEs. The OECD/INFE (2019) questionnaire includes common questions that are categorized into the three basic aspects of financial literacy: a. financial knowledge, b. financial behaviour, and c. financial attitudes. It then compiles all responses and brings back a score for each category and a total financial

[8]https://www.researchgate.net/publication/240619141_Personal_Finance_and_the_Rush_to_Competence_Financial_Literacy_Education_in_the_US

[9]https://www.oecd.org/finance/financial-education/OECD-INFE-core-competencies-framework-on-financial-literacy-for-MSMEs.pdf

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literacy score. As such, the methodology captures all different angles of financial literacy, specifically designed for micro and small entrepreneurs, thus providing a clear picture of the respective level of financial literacy of the respondents.

However, the OECD/INFE (2019) questionnaire uses input from MSMEs owners only and thus provides a relatively one-sided picture of the financial literacy level of MSMEs. We suggest that the OECD/INFE (2019) methodology should be accompanied and complemented with qualitative tools, to capture a broader range of the issue in question. This qualitative approach should capture the opinions of various stakeholders and relative institutions (i.e. banks, MSMEs representatives, alternative investment financiers, civil society organizations) in a way that discusses the MSMEs financial literacy related issues and provides a better understanding of the problem at hand.

3. Financial literacy and MSMEs financial performance

SMEs consist of the majority of enterprises worldwide, and significantly contribute to employment and value added. For example, in Europe, SMEs account for 99.8% of the total number of enterprises, employ the 65.0% of total number of persons employed and produce the 53.0% of total value added (SME Annual Report, 2022). In this respect MSMEs' economic and financial performance is rather crucial for inclusive growth. In this respect, G20 and OECD in their common publication on High-Level Principles on SME financing in 2015 set 11 principles for improving MSMEs financial literacy and access to finance. One of the principles suggests to "Enhance SME financial skills and strategic vision"[10].

Financial literacy is of crucial importance for businesses and especially MSMEs. One strand of the academic literature of SMEs is simply to measure financial literacy using various approaches, as discussed in the previous section. In this context, following on the literature references presented in the previous section, Fatoki (2014), showed very low levels of financial literacy for micro enteprises in the Johannesburg area, and Plakalovic (2015) also showed that only 20% of the business owners/managers in Banjaluka and East Sarajevo regions participants were found financial literate.

Some studies enlarge the research context and link financial literacy to specific entrepreneurship traits, within the individual approach of the researcher. In this context, the afore mentioned Sage (2012) survey showed that respondents were weak in dealing with taxes, managing sales and marketing, and managing the finances of their businesses and more competent at dealing with clients, dealing with suppliers and managing the finances of their businesses. Brown et al. (2006) indicated that despite the business owners' awareness of their lack in financial literacy, they barely understood what their exact financial needs are and also displayed a lack of knowledge on where to find products and services to cover these needs. Last, Pearl & Eileen (2014) showed that half of the start-up owners they researched did not review their financial statements regularly and experienced financial difficulties.

Apart from just measuring the level of financial literacy of MSMEs, many studies have shown significant relation of the level of financial education of MSME owners and the performance of the firm. For example, Fernandes (2015) surveyed a sample of 103 MSME owners in North Portugal and found that significant positive correlation between their financial literacy and the Return on Assets of their firms. Likewise, Menike (2019) addressed a questionnaire to 378 MSME owners in Sri Lanka investigating the effect of their financial literacy on their businesses sales, total assets and in the number of permanent employees as employed and found a positive impact. Additionally, as the findings of Bayrakdaroğlu & Şan (2014) and Wise (2013) support, the enhancement of financial literacy of SMEs could improve their access in financial market instruments and tools and thus strengthen their position.

4. Methodology

Based on the conceptual framework described above, we designed and applied an integrated approach, to capture MSMEs financial literacy in a multi-dimensional way. Specifically, we apply a two-stage methodology combining quantitative and qualitative information, collected from MSMEs themselves plus general stakeholders related with the issue in question, as follows. In stage one, we apply the OECD/INFE (2019) questionnaire, which was specifically designed to measure MSMEs financial literacy, considering this questionnaire as the most effective available tool to measure MSMEs financial literacy to date. In stage two, we design and apply a qualitative focus-group analysis methodology, where we create groups of stakeholders to discuss the MSMEs financial literacy issue. These two stages are discussed in detail in the paragraphs that follow.

Stage one: the OECD/INFE Questionnaire

The OECD/INFE (2019) questionnaire consists of around 50 questions[11] structured across the following categories:

1. Screening (QC1-QC5 questions)

The main purpose of these questions is to make sure that the respondent has some minimum features that qualify him/her to go on with the interview process. For example, if the respondent answers that he runs a branch or non-profit business, then the interview stops. Similarly, if the respondent answers that he is not the owner of the business,

[10]https://www.oecd.org/finance/G20-OECD-High-Level-Principles-on-SME-Financing.pdf

[11]The exact number of questions that each respondent is asked to provide answers to, depends on how the respondent answers in some specific questions, which may lead to additional questions that appear.

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then the interview stops. If the respondent answers that the company employs more than 50 employees, then the interview stops, etc.

2. Characteristics of the business (QC6-QC10 questions)

These questions are designed to capture firm specificities, like turnover, years in operation, exports, main activity (sector) etc.

3. Financial products (QP questions)

These questions capture the respondents' familiarity and usage of financial products. For example, if the company has a current/savings account at a traditional/online bank, if they have heard/used of bank overdrafts, business loans, invoice discounting, micro-credit, trade credit etc., how they made their choice about using a financial product or service, etc.

4. Managing and planning business finances (QM questions)

These questions capture how respondents think about and plan business finances, where entrepreneurs are asked if they have received any help from other people (i.e. business partners, book-keepers, business advisors, banks etc.) in taking financial decisions, if they have asked help for specific matters (i.e. how to manage cash, how to access external financing, advice on tax-issues etc.), how they keep track of the financial records of the business (i.e. with the use of a dedicated software, in paper form, via an accountant etc.), if they plan for retirement, how much they agree or disagree (4-level Liker scale) on specific statements about a range of business issues (i.e. data security, comparison of financing sources, profitability forecast etc.).

5. Financial knowledge and attitudes (QK questions)

These questions capture whether the respondent can understand simple financial concepts and tools like the interest, the balance sheet, dividends, equity, the Return-on-Assets ratio, etc.

6. Financial education and protection (QF questions)

The respondent is asked here if s/he has received any training on how to manage business finances, training on personal management and how if they train themselves regularly on business financing related issues.

7. Demographics (QD questions)

This category includes the usual demographics like gender, age, educational level, years of experience as a business owner etc.

8. Business performance (QG questions)

This category includes questions measuring the perceptions of MSMEs owners, if their business has been successful during the last year, if specific indicators (i.e. turnover, profits etc.) have increased and at what grounds the gross profit ratio was.

The overall financial literacy score is computed as the sum of the financial knowledge, financial behaviour and financial attitudes questions, where each category is called "aspect". It is important to note that *only a sub-set* of all questions contained in the eight categories above, are taken under consideration when calculating the individual score per financial aspect. Specifically, to calculate the individual score for the financial knowledge aspect, the OECD/INFE (2019) methodology uses 8 QK questions; to calculate the individual score for the financial behaviour aspect, the OECD/INFE (2019) methodology uses a mix of QP and QM questions, 10 in total; and to calculate the individual score for the financial attitudes aspect, the OECD/INFE (2019) methodology uses 4 QK questions. The exact questions per aspect and the exact answers and scores per question are shown in detail in the results section. For each correct answer, one (1) point is added to the score. The overall financial literacy score is determined in the following two simple stages.

First, the individual score for each of the three aspects (financial knowledge, financial behaviour, financial attitudes) is calculated. For each question used, all correct answers are added and then divided by the number of total answers; this provides the average score of each aspect:

$$Aspect_x = Avg\left(\frac{Sum\ of\ correct\ answers}{Total\ answers}\right)\ \% \quad (1)$$

Second, the following formula is applied to get the overall financial literacy score, which is the weighted average of the three aspects:

$$Overall\ Score = \frac{(Financial\ Knowledge\% * 8)+(Financial\ Behavior\% * 10)+(Financial\ Attitude\% * 4)}{22} \quad (2)$$

The OECD/INFE guidelines do not specify a score for an "acceptable" financial literacy level for the MSME survey. A target score would be helpful in identifying *relative* levels of financial literacy, per each aspect. However, in their adult survey, OECD-INFE (2020) report the average score per aspect and per country (p.17 / normalized to 100). Specifically, OECD/INFE (2020) reports an average overall financial literacy score of 60.5, allocated per aspect as follows: 62.8 for financial knowledge, 59.2 for financial behavior and 59.2 for financial attitude. These average figures provide respective thresholds for evaluating financial literacy levels. In this paper, we adopt these average scores reported in the OECD/INFE (2020) adult survey, as thresholds according to which the MSMEs financial literacy level is evaluated. The reason we compare adults' financial literacy (FL) to that of micro and small entrepreneurs (MSMEs) is twofold: a. there are already plenty of studies that look at adults' FL levels, but not many

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regarding MSMEs' FL levels, so we underline this gap in the literature, and b. there is no official threshold set from OECD for MSMEs FL, while there is indeed a respective threshold for the adults' category; thus, we use this figure as a threshold to assess the MSMEs FL levels accordingly.

Stage two: stakeholders' focus groups

The application of the OECD/INFE questionnaire provides interesting information, in a quantitative basis, from the entrepreneurs' perspective. This piece of information is important on its own, however it can be considered as relatively "narrow", because the source of the information is entrepreneurs themselves. To broaden the context of the financial literacy issue in question, we designed and implemented three focus groups, that consisted of different stakeholders related with this issue. Specifically, after having got the results of the questionnaire, and thus possessing important information of the entrepreneurs' views on several aspects of financial behaviour, attitudes and knowledge, we discussed these results with different stakeholders (funding schemes, Institutions, Business Associations, MSMEs owners etc.), to get their views and reflection. Specifically, we structured the interview process as follows: 1. we first communicated the main conclusions derived from the OECD questionnaire and replied to any questions the stakeholders had, regarding any results-related details, 2. we focused on specific issues that each specific stakeholder would be more fit to discuss, 3. we jointly shaped the stakeholder's conclusions, derived from the entire interview process. This way, we were able to a. inform stakeholders about the results of the questionnaire, b. gain insights of how they reflect on these results and what their views are, and c. initiate a discussion around this issue, that could lead to follow-up initiatives from the stakeholders' side. This is how we view the integrated approach on the MSMEs financial literacy field.

5. Data

There are two data collection exercises, each for each stage discussed in the methodology section. As regards stage one, where we collected data from face-to-face interviews from Greek entrepreneurs, we followed the OECD/INFE (2019) guidelines which are the following (in brief):

- Owners. The survey aims at interviewing the business owner (or one of them in case of multiple owners) as long as s/he is involved in taking financial decisions for the business.
- Business size. The survey covers owners of MSMEs, including self-employed people and one-person businesses, employing fewer than 50 people (including owners, managers, all types of part-time and full-time employees regardless of their job contract, but excluding unpaid family members).
- For-profit businesses. The survey focuses on businesses for profit and excludes not-for-profit organizations.
- Formal/informal businesses. Based on the national context, countries may decide whether and to what extent they would like to cover informal (non-registered) businesses. We only covered registered businesses.

Our final sample consists of 20 micro and small enterprises from various sectors (catering, insurance services, tourism, cleaning services, etc.), from the Attica province. All entrepreneurs were interviewed face-to-face, at their premises, and the data collection exercise took place during January to end of February 2021.

The second dataset consists of qualitative data on an open interview-based questionnaire, upon which an open discussion took place in the context of each focus group. The focus group participants were the following: a. focus group 1: 9 entrepreneurs who had already participated to the survey of stage 1, b. focus group 2: representatives of Bank of Greece and various funding schemes and c. focus group 3: social partners in Greece, ie the Association of Enterprises and Industries (SEV), the Hellenic Confederation of Trade and Entrepreneurship (ESEE), the Association of Industries Of Greece (SVE), the Chamber of Crafts and the General Confederation Professional Craftsmen of Greece (GSEVEE).

Specifically, the first group consisted of a sample of MSME owners who took part in the survey. The purpose of this first focus group was to inform MSME owners about the overall results of the survey stage, to discuss these results, to get their reflection on the most important issues revealed, and to therefore collect qualitative information to be communicated with the "external" stakeholders that would follow in the next two focus groups. The second focus group consisted of representatives of funding schemes and the Bank of Greece. The purpose of this focus group was to capture the reflection of the "financing supply" side of how they perceive the issue of financial literacy. The third focus group consisted of social partners and business associations in Greece. We discussed with them the overall results of the survey plus the main outcomes of the previous two focus group, in an effort to take the issue further at a policy design level, in the financial literacy context.

5. Results

Stage one: the OECD/INFE Questionnaire

In this section, we present the answers for each of the three dimensions of the overall financial literacy score[12]. Tables 1, 2 and 3 show the questions[13] that comprise the financial knowledge, financial behaviour and financial

[12] We only present the questions and respective results associated with the financial literacy score.

[13] We only show questions and results, and we do not indicative answers, to avoid excess table sizes. For the entire question including indicative answers please see the Appendix.

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attitude scores respectively, following the OECD/INFE guidelines. Scores are categorized as high (>65%), moderate (55-65%) and low (<55%). Table 4 shows the overall financial literacy score.

As regards financial knowledge, results show that respondents score relatively high in understanding the concepts of risk (QK7_4), and inflation (QK7_5), moderate to high regarding interest (QK3, QK4), moderate regarding dividends (QK7_2) and low in understanding the balance sheet (QK5), the ROA ratio (QK6) and the interrelation between equity and control (QK7_3). The total average score of the financial knowledge aspect (57.50%) is moderate (Table 1).

As regards financial behaviour, results show that respondents score relatively high in keeping track of financial records (QM3), in thinking about retirement (QM6), in theft strategies (QM8), and in forecasting profitability (QM9_4), moderate in keeping secure data and information (QM9_1), financial-based decision making (QM9_2) and adjusting business to economic factors (QM9_5), and low in keeping separate personal and business accounts (QP2), shopping around for a financial product/service (QP5) and comparing the cost of different sources of finance (QM9_3). The total average score of the financial behaviour aspect (64.50%) is also moderate (Table 2).

As regards financial attitude, results show that respondents score relatively high in a day-to-day effort to manage business finances (QK2_4) and setting long-term financial goals (QK2_1), and low in financial planning (QK2_5) and confidence in approaching external financing sources (QK2_2). The total average score of the financial attitude aspect (55%) is also moderate (Table 3).

Last, regarding the overall financial literacy score, this is formed at the level of 60.23% (Table 4).

Table 1: Financial Knowledge Questions and score

Question number	Question	Value towards final score	Correct answers	Correct answers/Total answers (%)
QK3	Imagine that someone puts €100 into a <no fee, tax free> savings account with a guaranteed interest rate of 2% per year. They don't make any further payments into this account and they don't withdraw any money. How much would be in the account at the end of the first year once the interest payment is made?	1 for correct response [102]. 0 in all other cases.	14	70%
QK4	…and how much would be in the account at the end of five years [add if necessary: remembering there are no fees or tax deductions]?	1 for correct response [More than €110]. 0 in all other cases.	13	65%
QK5	Could you tell me which of these best describes a balance sheet?	1 for correct response [1]. 0 in all other cases.	3	15%
QK6	Could you tell me which of these best describes the Return-on-Assets ratio (ROA)?	1 for correct response [3]. 0 in all other cases.	6	30%
QK7_2	Dividends are part of what a business pays to a bank to repay a loan	1 for correct response [false]. 0 in all other cases.	13	65%
QK7_3	When a company obtains equity from an investor it gives the investor part of the ownership of the company	1 for correct response [true]. 0 in all other cases.	8	40%
QK7_4	If a financial investment offers the chance to make a lot of money it is likely that there is also a chance to lose a lot of money	1 for correct response [true]. 0 in all other cases.	17	85%
QK7_5	High inflation means that the cost of living is increasing rapidly	1 for correct response [true]. 0 in all other cases.	18	90%
Total Average Score:				**57.50%**

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Table 2: Financial Behaviour Questions and score

Question number	Question	Value towards final score	Correct answers	Correct answers/Total answers (%)
QP2	Separation account: You mentioned that you have a current or savings account for your business. Can you tell me which of these statements best represents your situation?	1 for separate account [3]. 0 in all other cases.	8	40%
QP5	Shopping around: Which of the following statements best describes how you made your most recent choice about a financial product or service for the business?	1 for shopping around [1 or 4]. 0 in all other cases.	8	40%
QM3	Keeping track of financial records: How do you keep track of the financial records of the business?	1 for keeping track formally [1, 2, 4, 5]. 0 in all other cases.	19	95%
QM6	Thought about retirement: Have you thought about how you will fund your own retirement or maintain yourself when you will no longer work due to old age?	1 if thought about how to fund retirement [1]. 0 in all other cases.	15	75%
QM8	Strategies to cope with theft: Imagine that tomorrow you discover that most of the equipment that you need to operate the business has been stolen (it could be computers, vehicles or other equipment). Which one of these statements best represents what you would do?	1 for thinking ahead of a way of insuring the equipment [1 or 2]. 0 in all other cases.	15	75%
QM9_1	I keep secure data and information about the business	1 for agreeing [4 or 5]. 0 in all other cases.	13	65%
QM9_2	I decide whether to make an investment on the basis of the financial data of the business	1 for agreeing [4 or 5]. 0 in all other cases.	12	60%
QM9_3	I compare the cost of different sources of finance for the business	1 for agreeing [4 or 5]. 0 in all other cases.	10	50%
QM9_4	I forecast the profitability of the business regularly	1 for agreeing [4 or 5]. 0 in all other cases.	17	85%
QM9_5	I follow changes in economic factors to adjust the course of business operations	1 for agreeing [4 or 5]. 0 in all other cases.	12	60%
Total Average Score:				**64.50%**

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Table 3: Financial Attitude Questions and score

Question number	Question	Value towards final score	Correct answers	Correct answers/Total answers (%)
QK2_1	I set long term financial goals for the business and strive to achieve them	1 for long-term attitude [4 or 5]. 0 in all other cases.	15	75%
QK2_2	I am confident to approach banks and external investors to obtain business finance	1 for confident attitude [4 or 5]. 0 in all other cases.	5	25%
QK2_4	I try to influence the state of my business finances in the future with my day-to-day behavior	1 for long-term attitude [4 or 5]. 0 in all other cases.	16	80%
QK2_5	I prefer to follow my instinct rather than to make detailed financial plans for my business	1 for prudent attitude [1 or 2]. 0 in all other cases.	8	40%
Total Average Score:				**55.00%**

Table 4: Overall financial literacy score

	Financial Knowledge	Financial Behaviour	Financial Attitude	Overall Score
Total number of questions	8	10	4	22
Total number of participants	20	20	20	20
%	57.50%	64.50%	55%	60.23%

$$\frac{Financial\ Knowledge\% * 8 + Financial\ Behavior\% * 10 + Financial\ Attitude\% * 4}{22} =$$

$$\frac{(57.5\% * 8 + 64.50\% * 10 + 55.00\% * 4)}{22} = 60.23\%$$

This overall financial literacy score (60.23%) is very close to the pre-set threshold of 60.5%, as reported in the OECD/INFE (2020) adult survey.

Stage two: stakeholders' focus groups

We designed and organized three focus groups with stakeholders, as discussed in the methodology section.

The first focus group took place on 16/06/2021 and consisted of 9 MSME owners, who had previously taken part in stage one as respondents. We initially presented the questionnaire results and then asked the participants to comment on these results. The discussion that followed mainly focused around the competency areas that the scores were low. The main conclusions from this focus group are the following. The MSME owners mentioned that it is impossible for an entrepreneur to know ex ante if he meets the conditions for the approval of a bank loan (QK2_2), while they highlighted that, according to their views, banks do not seem to encourage entrepreneurs to possess high levels of knowledge around banking products and services (QP5), so that they remain dependent of the bank they already have a relationship with. MSME owners also highlighted that there is a lack of relevant educational programs regarding financial issues that concern them (QF1-not included in the financial literacy score), and that they typically ask help from a business partner or an accountant for such issues (QM1-not included in the financial literacy score).

The second focus group took place on 30/06/2021 and consisted of representatives from the Bank of Greece and various funding schemes, i.e. business angel investors, crowdfunding experts and one Initial Coin Offerings (ICOs) expert. Again, the meeting started by referring to the main results of the questionnaire, and a discussion followed. The Bank of Greece highlighted the importance of financial literacy of MSMEs. Representatives of the various financing schemes stressed that businesses have different needs and therefore entrepreneurs need a more individualized approach. In this respect, it would be more effective for an entrepreneur to work with a specialized consultant (QM1-not included in the financial literacy score) instead of attending generic educational programs. For the time being, the only field that entrepreneurs ask for external help from consultants is the field of tax and respective issues (QM2-not included in the financial literacy score).

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The third focus group which took place on 15/07/2021, and consisted of social partners and business associations, such as the Association of Enterprises and Industries (SEV), the Hellenic Confederation of Trade and Entrepreneurship (ESEE), the Association of Industries Of Greece (SVE), the Chamber of Crafts and the General Confederation Professional Craftsmen of Greece (GSEVEE). Social partners also stressed the need to improve MSMEs financial literacy through targeted actions and customized training tools. They specifically noticed that in the past they had implemented some programs for the improvement of economic/financial knowledge of their members but highlighted the absence of a rigid national strategy. Specifically, participants highlighted the need for training programs on personal money management (QF1-not included in the financial literacy score). Finally, they proposed the extension of the current study to a larger population in order to draw safer conclusions.

5. Conclusion and Recommendations

This paper explores the field of financial literacy of MSME owners, a relatively underdeveloped area in academic literature. We apply a two-stage methodology to suggest an integrated approach in measuring financial literacy; we first use the, specifically designed for MSMEs, OECD/INFE (2019) questionnaire, and we then discuss the questionnaire results and emerging issues thereafter with MSMEs owners themselves and various stakeholders. We thus capture aspects deriving from both the "demand side" of the MSMEs financial literacy field, namely the MSME owners themselves, as well as the "supply side", namely the various stakeholders interested in this field.

Our results show that the overall financial literacy score of small and medium entrepreneurs is 60.23%, very close to the international study on the general adult population conducted by the OECD/INFE in 2020. Regarding the three aspects of financial literacy, the financial knowledge and attitudes scores in our study is 57.5%, and 55% respectively, lower than the corresponding percentages of the OECD/INFE (2020) study, which stand at 62.8% and 59.2% respectively. On the other hand, the financial behaviour score we get from Greek MSMEs is 64.50%, higher than the 59.2% in OECD/INFE (2020). As regards the input we got from the qualitative aspect of our study from the focus groups with stakeholders, one main conclusion was that all stakeholders highlighted the importance of financial literacy of MSMEs. Also, stakeholders mentioned that businesses have different needs and therefore entrepreneurs need a more individualized approach and that, in this context, specialized consultants could play a significant role. Last, MSMEs organizations focused mainly on the various training programs that could be shaped in the financial literacy field. Overall, Greek MSMEs seem to lie at a moderate level of financial literacy, while stakeholders have expressed their interest in this field, and have highlighted specific actions that can be taken to improve this field. The fact however that there are relatively big variations across the *individual* questions per aspect of financial literacy, is very helpful in identifying specific actions in areas that MSMEs owners score low.

The main limitation of this study is the small sample of MSME owners that participated in the first stage of our methodological approach. However, the main purpose of this paper is not to focus on the results themselves, rather, it is to suggest an integrated approach of measuring financing literacy of MSMEs owners, that could be applied in other countries as well. Therefore, as regards the present study, expanding it to a larger population is a key priority in order to analyze a larger sample of companies covering all areas of entrepreneurship. This would allow us to explore possible differentiations across various features of MSMEs owners, for example the industry factor, the age and education levels of MSMEs, etc., analyses which now cannot be conducted because of the very small sample of our study.

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The Difference in Parental Financial Socialisation Across Parental Income Level[1]

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ABSTRACT

Purpose:
The effect of parental income on parental financial socialisation is increasingly becoming important. The objective of this study was to determine the difference in parental financial socialisation across parental income levels. This study was guided by financial socialisation theory which is not only about learning financial skills, attitudes, standards, norms, and behaviours from childhood through adolescence, but is more concerned about what the socialisation process contributes to the overall financial well-being of individuals.

Design/methodology/approach:
Quantitative research approach was adopted for this study. Self-administered questionnaire was used to collect data among 500 young adults in South Africa. Descriptive statistics, Levene's test, Welch robust test, Tukey HSD test and ANOVA were used to analysed data. Four hypotheses were tested. Parental financial socialisation was measured through parental financial behaviour, parental financial monitoring, parental financial discussions, and parental financial communication.

Findings:
The results showed that there was a significant difference in Parental financial behaviour, parental financial monitoring, parental financial discussions, and parental financial communication across Parental income. Therefore, the overall results indicated that there was a significant difference in Parental financial socialisation across Parental income.

Research limitations/implications:
Due to the low levels of general literacy among the respondents, which negatively affected data collection; some young adults did not understand the questionnaire and withdrew from participating in the study. Furthermore, even though confidentiality and anonymity were guaranteed, respondents were reluctant to participate in the study. They feared exposing their financial position and displayed a lack of trust.

Originality/value:
The current study contributed to the body of knowledge differently to the previous studies because it focused on parental financial socialisation of young black African adults in rural and low-income area This study is the first to investigate the difference in parental financial socialisation across parental income levels. This makes this study so important and warrant that it should be carried out to provide the much-needed results that could help to improve parental financial socialisation across all income levels.

[1] This study is based on the PhD's thesis entitled "The influence of parental financial socialisation on financial literacy of young black African adults in rural and low-income area in South Africa" of the corresponding author.

1. Introduction

Parental income level has recently gained increasing importance globally, because of its possible effect on parental financial socialisation. Parental income level has an influence on their role in raising children (Salim & Pamungkas, 2022). Studies have also showed that parental income has a significant effect on young adult's financial literacy and personal financial management (Ismail et al., 2022; Radianto et al., 2019; Homan, 2015). Thus, parental income level has consistently been found to be an important factor in parents' and young adult's lives. However, it remained to be seen and proven beyond doubt if parental income level plays a role in parental financial socialisation. The argument is that there seem to be differences in parental financial socialisation across parental income level. Parents have different income levels and thus they might engage in parental financial socialisation differently. It is noted that parents with higher income are more likely to get involved in financial socialisation (Serido et al., 2020). The lack of parental financial socialisation has a tremendous impact on how young adults manage their finances and their overall financial well-being. Thus, it is important that young adults irrespective of their parental income levels get the relevant and appropriate parental financial socialisation. Thus, young adults must be financially prepared during their transition into adulthood. Parental financial socialisation in childhood has a strong relationship with sound financial practices and asset ownership in young adulthood. Therefore, if there is something that can hinder parents to engage in financial socialisation it must be established and known so that the necessary interventions can be made to ensure that parental financial socialisation takes place, because it is important in how young adults engage in financial matters. Studies that have investigated the difference in parental financial socialisation across parental income level are very scant, especially in developing countries like South Africa. The few notable studies were conducted mainly in developed countries in Europe (Ekstrom et al., 1987; Arikan,1991; Furnham,1999; Jorgensen & Salva, 2010; Serido, Shim et al., 2010; Gudmunson & Danes, 2011; Serido et al., 2020). There is no study which has focused on the difference in parental financial socialisation across parental income levels in South Africa. The current study will investigate this issue to contribute to literature and to fill the identified research gap. It is important that the difference in parental financial socialisation across parental income levels in South Africa be investigated so that the government can come up with programmes to address the gaps in parental financial socialisation. Parental financial socialisation is investigated through parental financial behaviour, parental financial monitoring, parental financial discussions, and parental financial communication. The objective of this study was to determine the difference in parental financial socialisation across parental income levels.

The remainder of this article is structured as follows: Sections 2 provides literature review. Section 3 explores research and methodology of the study. Section 4 covers analysis and findings the study. Section 5 provides conclusions and recommendations of the study.

2. Review of Literature

2.1 Theoretical Review

2.1.2 Financial Socialisation Theory

Financial socialisation was derived by Danes (1994) from the definition of consumer socialisation of Ward (1974). The terms *financial socialisation* and *consumer socialisation* are sometimes used interchangeably in literature on the development of children's financial literacy; however, these terms are different. Danes (1994) argued that financial socialisation is the process whereby people obtain and develop financial knowledge, values, and behaviour that affect their financial behaviour and money management. This definition of Danes (1994) provides a comprehensive view of financial socialisation and includes the concepts of financial viability and well-being. Thus, financial socialisation is not only about learning financial skills, attitudes, standards, norms, and behaviours from childhood through adolescence, but is more concerned about what the socialisation process contributes to the overall financial well-being of individuals. Financial socialisation is a life-long process that is influenced by numerous socialisation agents, such as family, teachers, peers, and the media. Factors such as gender, socio-economic conditions of the family and the surrounding community, race, ethnicity, types of financial products that are available, public policies, and macro-economic trends are likely influential in financial socialisation (Gudmunson et al., 2016). The comprehensiveness of financial socialisation is evidenced by the many broad areas of money handling, such as learning about earning, spending, saving, borrowing, sharing, maintaining, and increasing money, insurance, taxes, wills, and investment (Alhabeeb, 1996). According to Fox et al. (2005), saving- and spending behaviours begin to form at an early age. These behaviours start within the family, through both formal and informal methods of teaching. This teaching includes the intergenerational transfer of knowledge, which occurs through observation, modelling, informal discussions, and direct teaching, which can help adolescents and young adults develop behaviours that lead to financial well-being throughout their life (Shim et al., 2010). According to Allen (2008), young adults reported that they learned most of their financial management knowledge and -skills from their parents. Thus, good financial attitudes are significantly related to better financial behaviours such as saving and money management and are negatively correlated to problematic outcomes such as financial distress (Shim et al., 2010). However, the field of financial socialisation still lacked proper direction due to a lack of consensus on a conceptual model and measurements. Despite this, financial socialisation theory remained the most widely used theory in the field of financial socialisation.

2.2 Previous studies

Parental financial socialisation is a development of socialisation process where the parents transfer knowledge and skills on financial matters either intentional or unintentionally that shape, develop skills, knowledge, attitude, and

financial practices of young adults (Bakar & Bakar, 2020). Parents are at the core of these processes through direct and indirect communication, both in their spoken words and in their patterned behaviours as a direction to follow. However, greater understanding is needed about the difference in parental financial socialisation of young black African adults in rural and low-income areas in South Africa. This study measured parental financial socialisation through parental financial behaviour, parental financial monitoring, parental financial discussions, parental financial communications, and parental financial teaching.

Parental financial behaviour as a component of parental financial socialisation manifest itself through observation of good or bad financial behaviours of parents by their children. Thus, children view their parents as role models and do what their parents did when they reach adulthood (LeBaron et al., 2019). Parents financially socialise their children through their modelling of consumer behaviour (Allen, 2008). According to Mohamed (2017), observing parents' financial behaviour and -interactions at an early age is positively related to young adults' acquisition of financial knowledge. Otto (2009) investigated parents' role in the development of their children's saving skills during adolescence. The study found that parents' saving example influenced their children's saving skills. Webley & Nyhus (2006) posit that, as role models, parents influence their children's future saving- and borrowing behaviour. When parents save, their children know that saving is a good thing (Bucciol & Veronesi, 2014). Hibbert et al. (2004) assessed the impact of modelling on financial behaviour and found that students who were raised in a financially prudent household, where parents saved and paid their bills on time, self-reported fewer negative financial behaviours such as misusing credit cards and making unaffordable purchases.

H1: There is a significant difference in parental financial behaviour across parental income levels.

Parental financial monitoring is a direct way of financially socialising children and includes making rules about children's financial behaviours (Allen, 2008; Jorgensen, 2007; Kim & Chatterjee, 2013). The importance of parental monitoring is visible in the development of sensible financial attitudes. Norvilitis & MacLean (2010) found that parental monitoring of children's financial skills is associated with improved financial skills in dealing with debt, which ultimately leads to lower levels of debt. Parents have the ability to influence their children by monitoring their spending patterns and pushing their behaviour in certain directions to prevent unwanted habits from being formed (Webley & Nyhus, 2006). One method of financial monitoring is is giving children an allowance which makes them responsible for managing their own money. This teaches them to make their own decisions, which leads to experience in making financial decisions. Parents only get involved by checking and asking how they are using the money (Webley & Nyhus, 2013).

H2: There is a significant difference in parental financial monitoring across parental income levels.

Parental financial discussions are sometimes referred to as *parental financial communication* in financial socialisation literature; however, the two concepts are not the same. Parental financial discussion is a process whereby parents openly discuss financial matters with their children and allow input from their children (Kim & Torquati, 2019). This is not a one-way process; children are not only considered receivers of financial information, but they can also advise their parents, and the parents involve the children in major financial decisions. Webley & Nyhus (2006) assert that explicit financial discussions with children have a direct impact on the children's future financial behaviour. Financial discussions can shape children's spending behaviours and attitudes by providing parents with an opportunity to engage in direct discussions about purchasing decisions, money, credit, and related topics (Allen, 2008; Agnew, 2018). Fulk & White (2018) indicate that parental discussions about money have the biggest overall influence on college students' money-management behaviour. These students were found to be more likely to pay their credit card bill on time and in full each month.

H3: There is a significant difference in parental financial discussions across parental income levels.

Parental financial communication is a tool for educating children about financial issues such as saving, budgeting, investing, consumer skills, avoiding financial problems, and building a strong foundation for financial well-being (Allen, 2008; Kim & Torquati, 2019). Parental financial communication involves speaking to children about finances without necessarily requiring their inputs. Children are therefore not involved in family financial matters — they are only informed. An example is parents explaining the family's spending plan to their children so that they are not surprised if certain items are not considered in the household spending plan or not purchased at all. Parental financial communication is linked with positive financial outcomes in adulthood (Isomidinova & Singh, 2017). A study of children aged eight to 18 years reported that parental communication about charitable donations is positively associated with children's saving for their future education and the tendency to donate to charities (Kim et al., 2011).

H4: There is a significant difference in parental financial communication across parental income levels.

2.3 Parental income level

Arikan (1991) posited that parents with a high income may be inclined towards luxury consumption motivated by showing off to secure a higher status in the community. Such parents spend their surplus income instead of saving it. This behaviour is then observed by their children and may manifest in the same behaviours by the children (Arikan, 1991). However, Furnham (1999) found that saving rates are higher amongst children with parents with a higher income. Sherraden (2013) adds that parents with a low income are also less likely to socialise their children financially. Thus, children from low-income homes have less experience with money and could be less aware of the range of consumer goods. However, Ward (1974) argued that children from low-income homes are more likely to be skilled consumers, because they have had to learn disciplined use of scarce resources. Gudmunson & Danes (2011) assert that

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income underpins parents' ability to foster desirable financial practices in their children, which could lead to better financial outcomes in adulthood. Serido et al., (2010) argue that parental income plays an important role in parent–child financial interactions, which then impact their development of financial coping behaviours. Parents with financial wealth can provide more human, social, and financial resources for the development of the child, and are thus better able to foster positive financial practices. These parents are also in a better position to enhance young adult children's asset acquisition through parental access to financial institutions (Kim & Chatterjee, 2013).

3. Methodology

This research used a quantitative research approach, as it allows for stable and predictable world which gives the research more control over external factors in testing the relationship between variables and expressing or explaining a phenomenon in amount or quantity (Adams et al., 2014). This approach is associated with methodological principles of positivism, especially when used with predetermined and highly structured data collection techniques (Saunders et al., 2016). This study used self-administered questionnaire which were distributed to respondents' homes to collect data. Questionnaire were design in line with the objective of the study and used existing Likert type scales adopted from literature and also self-constructed scales. The Likert scale consisted of 5-point scales that ranged from strongly disagree (1) to strongly agree (5). Likert scales and closed-ended questions were used since this approach is easily standardized, simple to administer, quick, and relatively inexpensive (Bhandarkar & Wilkinson, 2010). To ensure face and content validity, questionnaires were designed based on the study's objective to provide comprehensive and relevant data. They were also submitted to academics and experts in financial socialisation to evaluate whether the measures cover the facets that make up the concept. Their inputs were reviewed, and where appropriate, the questionnaire was revised.

Study area for this study is rural and low-income areas in South Africa. Limpopo's Featkgomo Tubatse municipality and Eastern Cape's, Ntsika Yethu were declared as the most rural and low-income municipalities in South Africa (StatsSA, 2022). This study's target population was young black African adults in Fetakgomo Tubatse and Intsika Yethu municipalities.

This study used purposive sampling, cluster sampling, random sampling, proportionate stratified sampling, and systematic sampling because they afforded all young black African adults in Fetakgomo Tubatse and Intsika Yethu municipalities an equal chance to be included in the sample (Babbie, 2013). Purposive sampling was used to sample Fetakgomo Tubatse and Ntsika Yethu municipalities because they are the most rural and low-income areas in South Africa. Thereafter, cluster sampling was used to divide and group each municipality into wards, villages, and households where young black African adults were visited. Random sampling was used to sample wards from each municipality, where a ward number of each ward was written on a piece of paper, folded, placed in a box, and picked one by one until the number of desired wards was reached. In order to ensure enough representation in this study, at least 50% of the wards were selected. The municipality of Fetakgomo Tubatse comprises 39 wards, with 342 villages and 189,269 households. Therefore, 19 wards (39x0.50) are selected. Since Intsika Yethu Municipality is made up of 21 wards, with 214 villages and 40,448 households, 10 wards (21x0.5) are selected. Proportionate stratified sampling was used to apportion the sample size to each municipality and each selected ward based on the population proportion percentage. Simple random sampling was applied again to select villages and households in each ward as young black African adults were visited at their homes to collect data.

The first village from each ward, together with the first household, was randomly selected, but if there were no respondents that met the inclusion criteria in the first household, the next household was visited. Afterward, a systematic sampling method was used, where households were selected per interval. As the first household was selected randomly, a systematically procedure was followed as per the determined interval (Godwill, 2015). The interval was calculated by dividing the sample size by sampling wards (Salkind, 2017). For instance, in Fetakgomo Tubatse municipality, the researcher counted households from 1 to 15 from both sides of the street, then the 16th (306/19) household was selected. For Intsika Yethu municipality, the interval was 7 (78/10); thus, the researcher counted from 1 to 6 from both sides of the street, then the 7th household was selected. If no young adults, the next household was visited. This procedure was repeated until a household with young adults was found then the counting started again. The same procedure was followed in the next village until the sample size was reached. After that, the next ward was visited, applying the same procedure until the data collection was completed by reaching the required sample size. A sample size 0f 500 was set, calculated through Yamane (1967) formula, Krejcie & Morgan's (1970) table and considering the recommended sample size for conducting Exploratory Factor Analysis (EFA). A total of 423 young black African adults completed the questionnaires, giving a response rate of 94% which was good and acceptable.

Completed questionnaires were checked for missing data, and incomplete questionnaires were not considered for data analysis. Microsoft Excel was used to capture data, which were later transferred to SPSS version 25 for further analysis. This study assessed validity and reliability before data could be subjected to extensive statistical analysis. Validity was measured through EFA by conducting a KMO and Bartlett's test of sphericity. The acceptable value of KMO, which is considered suitable and adequate for EFA, is 0.50 and above. While Bartlett's test of sphericity was significant and suitable for EFA with a significance value of 5% percent, factors loadings of ±.30 to ±.40 are minimally acceptable since values greater than ±.50 are generally considered necessary for practical significance (Williams et al., 2010; Hair et al., 2014). This study retained a minimum factor loading of 0.35 for the interpretation. Reliability was measured through Cronbach's alpha, as it is the most widely used reliability measure of internal consistency (Vanderstoep & Johnson, 2009). Cronbach's alpha with a score of 0.60 and more is usually acceptable and

considered reliable (Cohen et al., 2018). Descriptive statistics were used to test the formulated hypothesis for this study.

4. Results

This section presents the empirical findings and interpretations of the research.

To assess the suitability of data to conduct EFA, KMO and Bartlett's test of sphericity was used in this study. Table 1 shows the results of the KMO and Bartlett's test of sphericity.

Table 1: KMO and Bartlett's Test

		Bartlett's Test of Sphericity		
Factors	**Kaiser-Meyer-Olkin Measure of Sampling Adequacy (KMO)**	**Chi-Square**	**df**	**Sig.**
Parental financial behaviour	0.755	833.565	8	0.000
Parental financial monitoring	0.866	3412.603	43	0.000
Parental financial discussion	0.633	329.856	12	0.000
Parental financial communication	0.969	2126.656	14	0.000

Source: Author's construct

Table 1 showed that the KMO for all factors ranged from 0.633 to 0.969, above 0.60. The p-value of the Bartlett's test for all factors (p=0.000) is smaller than 0.05, is significant. This result is an indication that the correlation structure of construct is adequate to conduct a factor analysis on the items and that all factors are regarded as valid and reliable. Therefore, EFA can be conducted.

Table 2 shows the results of the EFA, reliability by depicting the Cronbach's alphas, and descriptive statistics for the constructs and factors of the study.

Table 2: Validity, reliability, and descriptive statistics results

Factors	**EFA factor loadings**			**CA**	**Descriptive statistics**	
Variables	**Items**	**Highest**	**Lowest**	**α**	**μ**	**SD**
Parental financial behaviour	5	0.945	0.631	0.946	3.31	1.24
Parental financial monitoring	4	0.938	0.419	0.860	3.23	1.17
Parental financial discussion	5	0.879	0.555	0.923	3.12	1.26
Parental financial communication	4	0.927	0.665	0.945	2.90	1.38

Source: Author's construct

Table 2 indicated that five factors were extracted by the EFA, with all items loaded onto the factors as expected, with loadings of above 0.30. The overall factor loadings range from 0.419 to 0.945. The Cronbach's alpha coefficients were above 0.6 and were acceptable and considered reliable. The descriptive statistics provided the means and standard deviation. Regarding the means, majority of respondents agreed with the statements measuring parental financial behaviour (3.31), parental financial monitoring (3.23), and parental financial discussion (3.12) and disagreed with statements measuring parental financial communication (2.90). The standard deviations of all factors are high showing that the respondents' responses varied. However, parental financial communication had the highest standard deviation of 1.38 indicating that the responses varied mostly about this factor's statements. Therefore, data was prepared and ready for further analysis. Thus, the hypothesis for this study can be tested.

Table 3 shows the results of Levene's test of homogeneity of variance between *Parental income* and the components of *Parental financial socialisation*, namely *Parental financial behaviour*, *Parental financial monitoring*, *Parental financial discussions*, and *Parental financial communication.*

Table 3: Tests of homogeneity of variances for *Parental income* and *Parental financial socialisation*

	Levene statistic	**df1**	**df2**	**Sig.**
Parental financial behaviour	34.868	4	467	0.000
Parental financial monitoring	14.773	4	467	0.000
Parental financial discussions	16.019	4	467	0.000
Parental financial communication	13.360	4	467	0.000

Source: Author's construct

Levene's test for equality of variance revealed that all components of *Parental financial socialisation* showed different variances across the groups. All had a p-value < 0.05. To determine the difference in the mean scores, the Welch robust test of equality of means was conducted. Table 4 reports the results.

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Table 4: Robust tests of equality of means of *Parental income* and *Parental financial socialisation*

		Statistic	df1	df2	Sig.
Parental financial behaviour	Welch	101.160	4	135.538	0.000
Parental financial monitoring	Welch	68.510	4	157.282	0.000
Parental financial discussions	Welch	105.669	4	143.228	0.000
Parental financial communication	Welch	80.901	4	132.830	0.000

Source: Author's construct

The test for equality of means revealed differences in mean scores across *Parental income* for *Parental financial behaviour*, *Parental financial monitoring*, *Parental financial discussions*, and *Parental financial communication*. All the *p*-values were less than 0.05. The Tukey HSD was used to conduct post hoc tests to show homogenous groups and where the differences lay. Table 5 reports the results of the Tukey HSD test of homogenous subsets.

Table 5: Tukey HSD test of homogenous subsets of the relationship between *Parental income level* and *Parental financial socialisation*

Parental financial behaviour

Tukey $B_{a,b}$				
Income	*N*	Subset for α = 0.05		
		1	**2**	**3**
R5001–R10 000	131	2.3924		
less than R5 000	152		2.8697	
R20 001+	26			3.9231
R10 001 – R15 000	85			4.1059
R15001 – R20 000	78			4.3359

Parental financial communication

Tukey $B_{a,b}$			
Income	*N*	Subset for α = 0.05	
		1	**2**
R5001-R10 000	131	2.1584	
less than R5 000	152	2.4474	
R10001-R15 000	85		3.7471
R20 001+	26		3.7788
R15 001-R20 000	78		4.1603

Parental financial monitoring

Tukey $B_{a,b}$				
Income	*N*	Subset for α = 0.05		
		1	**2**	**3**
R5001 – R10 000	131	2.6240		
less than R5 000	152	2.8980		
R10 001 – R15 000	85		3.7382	
R15 001 – R20 000	78		3.9391	
R20001+	26			4.3558

Parental financial discussions

Tukey $B_{a,b}$				
Income	*N*	Subset for α = 0.05		
		1	**2**	**3**
R5 001 – R10 000	131	2.1664		
less than R5 000	152		2.7408	
R10 001 – R15 000	85			3.9176
R15 001 – R20 000	78			4.0692
R20 001+	26			4.2000

Source: Author's construct

The following hypotheses were tested:

H1: There is a significant difference in parental financial behaviour across parental income levels.

The results showed that there were three homogeneous groups with regard to *Parental financial behaviour*. This means that there was a difference in *Parental financial behaviour* across *Parental income*. Group 1 had the highest mean score for *R5 001 – R10 000* (M = 2.392), and Group 2 had the highest means score for *Less than R5 000* (M = 2.869). These means scores were slightly lower than those of Group 3 for *R20 000+* (M = 3.923), *R10 001 – R15 000* (M = 4.105), and *R15 001 – R20 000* (M = 4.335). Therefore, parents with a high-income level are more likely to display high parental financial behaviour. ANOVA established a strong statistically significant relationship between *Parental income* and *Parental financial behaviour*, with F = 69.246 and *p* = 0.000. Thus, there was a significant difference in *Parental financial behaviour* across *Parental income*, and the hypothesis was accepted.

H2: There is a significant difference in parental financial monitoring across parental income levels.

The results indicated that there were three homogeneous groups for *Parental financial monitoring*. Therefore, there were a statistically significant differences in *Parental financial monitoring* across *Parental income*. Group 1's mean scores for *R5 001 – R10 000* (M = 2.624) and *Less than R5 000* (M = 2.898) were lower than the mean scores for Group 2, which were M = 3.738 for *R10 001 – R15 000* and M = 3.939 for *R15 001 – R20 000*. Group 3's parents earned a high

income, evident in the highest mean score for *R20 000+* (M = 4.355). This suggests that parents with a higher income are more likely to monitor their children's finances. ANOVA showed a strong statistically significant relationship between *Parental income* and *Parental financial monitoring*, with F = 39.584 and $p = 0.000$. Therefore, the hypothesis was accepted.

H3: There is a significant difference in parental financial discussions across parental income levels.

The results showed that there were three homogeneous groups. This meant that there were differences in *Parental financial discussions* across *Parental income*. Group 1's mean score for *R5 001 – R10 000* (M = 2.166) and Group 2's mean score for *Less than R5 000* (M = 2.740) were lower than the mean scores for Group 3 for *R10 001 – R15 000* (M = 3.917), *R15 001 – R20 000* (M = 4.069), and *R20 000+* (M = 4.200). Thus, the higher the parental income is, the more likely it is that the parents will discuss family financial matters with their children. ANOVA indicated a strong statistically significant relationship between *Parental income* and *Parental financial discussions*, with F = 79.124 and $p = 0.000$. Therefore, the hypothesis was accepted.

H4: There is a significant difference in parental financial communication across parental income levels.

In terms of *Parental financial communication*, the results revealed that there were two homogenous groups. Group 1's mean scores for *R5 001 – R10 000* (M = 2.158) and *Less than R5 000* (M = 2.447) were lower than the mean scores of Group 2 for *R10 001 – R15 000* (M = 3.747), *R20 000+* (M = 3.778), and *R15 001 – R20 000* (M = 4.160). This means that parents with a high income are likely to communicate financial matters with their children. ANOVA established a strong statistically significant relationship between *Parental income* and *Parental financial communication*, with F = 65.831 and $p = 0.000$. Thus, this hypothesis was accepted.

Based on the results of all hypotheses, Table 6 indicates the hypotheses decisions.

Table 6: Hypotheses decision

Hypotheses	Decision
H1: There is a significant difference in parental financial behaviour across parental income levels.	**Accept**
H2: There is a significant difference in parental financial monitoring across parental income levels.	**Accept**
H3: There is a significant difference in parental financial discussions across parental income levels.	**Accept**
H4: There is a significant difference in parental financial communication across parental income levels.	**Accept**

Table 6 indicated the decisions of hypothesis. All the hypotheses H1, H2, H3, and H4 were accepted, as there is a significant difference in parental financial behaviour, parental financial monitoring, parental financial discussions, and parental financial communication across *Parental income* levels. As all hypotheses were accepted, it indicates that there is a significant difference in parental financial socialisation across parental income levels. The results of this study are the first to indicate that there is a significant difference in parental financial socialisation across parental income levels. The results of this study will serve as a base for future studies to be conducted in this area.

5. Conclusion and Recommendations

The objective of this study was to determine differences in parental financial socialisation across parental income levels. Parental financial socialisation was measured through parental financial behaviour, parental financial monitoring, parental financial discussions, and parental financial communication. Descriptive statistics, Levene's test, Welch robust test, Tukey HSD test and ANOVA were used to analysed data. Four hypotheses were tested. The results showed that there was a significant difference in Parental financial behaviour, parental financial monitoring, parental financial discussions, and parental financial communication across parental income levels. Therefore, the overall results indicated that there was a significant difference in parental financial socialisation across Parental income. Thus, parents with high income tend to financial socialise their children more than those with low income. Thus, parental income is important in parental financial socialisation. This study is amongst the first to investigate the difference in parental financial socialisation across parental income levels. Therefore, there is still need for more studies that must be conducted. The results of this study can be used as a base for other future studies to be conducted in this area. This study recommends that researchers must explore further the differences in parental financial socialisation across parental income in other regions. Furthermore, it is recommended that the government of South Africa must come up with initiatives to address and improve parental income as it has been shown that parents with higher income are more likely to engage in parental financial socialisation which will in turn have an impact on financial literacy and financial well-being of young adults. Financial services providers and professionals in the field of finance must design financial programmes targeting parents across different income levels.

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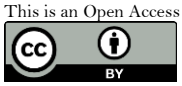

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Analysis of the Volatility of Wind Energy Production in Romania Applying the EGARCH Model

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ABSTRACT

Purpose:
The objective of the paper is to highlight the volatility of wind energy production, the renewable source of energy whose output is the most difficult to predict due to its dependence on climatic factors. The present research helps to analyze the risks assumed both by the producers who choose to invest in wind farms and the operator who has to balance the national energy system in case of production fluctuations. Many times, these risks are taken over, without their knowledge, by the final consumers who have to pay higher prices for the energy consumed.

Design/methodology/approach:
In this study, the EGARCH model was applied with the help of EVIEWS 12 software on a data series updated at least every 10 hours (1405 entries) regarding the evolution of wind energy production from January 2021 to January 2023. As a rule, the EGARCH model is used to analyse the volatility of indices in the financial field, but the present study, as well as others before, showed that it also fits perfectly in the case of renewable energy, the statistical tests applied to the results proving this fact.

Findings:
The results of the study show a GARCH term of 0.936, which points out a volatility comparable to some of the riskiest international stock indices.

Research limitations/implications:
This volatility is reflected through increases in balancing costs, ultimately borne by the energy consumers on the national market. Against this background, it is necessary to increase the stability of the national energy system, so that the balancing process would be less expensive and less dependent on imports. The solutions are varied - from the creation of stable non-polluting production capacities, such as the nuclear ones, to the thorough analysis of the characteristics of the areas where production systems from renewable sources are installed. It must be mentioned that the main limitation of this study is the long period considered, because the accuracy of the results could be better if the model was applied several times for data from consecutive, shorter periods.

Originality/value:
This study contributes to the theoretical identification of methods to forecast the volatility of renewable energy production and to highlight the vulnerabilities of increasing the share of this energy in the European energy mix.
It tests the use of heteroscedastic models to estimate the volatility of the wind power supplied to the system, unlike most studies in the literature, which analyze the volatility of the energy market price.
In addition, it proposes some solutions that could reduce or control this instability and ensure the regional energy security.

1. Introduction

The European energy sector is going through a major change of paradigm and structure, led by the European Green Deal, whose objectives drastically limit the prospects of conventional production technologies. By 2050, at least in theory, they will be completely replaced by non-polluting and renewable sources, which may open up new environmentally friendly business opportunities, but may also open a pandora's box in terms of energy supply for European consumers, if the vulnerabilities of these technologies are ignored.

Currently, the main vulnerability of energy production from renewable sources is their dependence on climatic factors, uncontrollable by humans, which cause a high volatility of the energy introduced into the system by some categories of production technologies, especially wind and photovoltaic. The first of these is by far the most unstable source of green energy, but it also has many advantages, such as high efficiency relative to the land area occupied and low operational costs.

Although wind farms are among the most efficient electricity production capacities, they are also the most volatile, and the low production costs are counterbalanced by high balancing costs of the energy systems in which they contribute considerably. The short period of time in which the wind can change its speed and the low ability to forecast these changes makes it even more difficult to integrate wind farms into the national energy mix compared to other sources of green energy.

In the first half of 2023, according to data provided by Transelectrica (the transmission and system operator in Romania), wind energy provided, on average, 15.46% of the national electricity consumption, reaching maximum values of 2.7 MW, of twice as much as the Cernavodă nuclear power plant. However, there were also periods while the production dropped to 0. Those declines led the system operator to turn to other sources, sometimes even to imports or coal power plants, when hydro plants were already operating at full capacity.

The problem of the volatility of renewable energy sources and the need to improve its forecasting methods has not yet been sufficiently well analyzed in the specialized literature, and in practice balancing the system as a result of large fluctuations in green energy production is rather achieved through momentary improvisations (purchasing from the spot market at high prices), than through well-established methods and strategies designed to prevent increased acquisition costs of the transport operator and tense situations or interruptions in the supply of consumers.

This paper aims to test the effectiveness of the application of the EGARCH model to estimate the volatility recorded by wind energy production in Romania, between 2021 and 2023, the period that coincided with the economic recovery process after the coronavirus pandemic, the energy crisis generated by the increase in the price of natural gas and with the acceleration of the targets assumed by European Union through the Green Deal.

Later, in order to estimate the impact of the wind energy production on the energy sector in Romania, it was calculated the correlation between it and the total energy production, energy exports and imports and the energy available for balancing (formed by the sum of the production from conventional sources and imports from neighboring states). The results showed that Romania is turning to imports to compensate for the decrease in the production of wind farms, as conventional sources have already become insufficient to ensure the national needs, many being closed as a result of the anti-pollution policies agreed with the European Union.

In the first part of the paper, it can be found a brief introduction of the main specialized works that addressed the issue of the volatility of renewable energy sources, the results and the opinions of specialists regarding this challenge. There were identified some different currents of opinion regarding the impact of the volatility on the energy sector, mostly because the increase in green energy production causes prices to fall, but their instability causes the risks assumed by companies to increase. Afterwards, there is presented the research method used in the study and the stages that were followed, after which the results obtained are presented and discussed. Finally, the conclusions of the research were stated, its limitations were highlighted and it was made a brief comparison with other studies in the field.

This paper contributes to the effort of the specialized literature to identify and test methods for analyzing energy volatility and forecasting its evolution over time. The higher the percentage of renewable energy in the national energy mix, the greater its volatility and the higher the balancing costs, because the market for this activity is often speculated by producers. Thus, it is necessary to identify some solutions to reduce the impact of this characteristic of renewable energy sources on the national system. So far, in most researches where heteroskedastic models are applied for energy variables, they are used to analyze the volatility of energy prices and not the volatility of energy inputs into the system.

2. Review of Literature

The costs for renewable energy production technologies have fallen considerably in recent years, making them attractive to both investors and household consumers who choose to produce some of the energy they use themselves. In some cases, such as photovoltaic panels, prices have fallen by as much as 90% in the last 10 years. However, the increase in the percentage of the energy mix occupied by renewable sources has not increased enough to achieve the goals of the Paris Treaty, and even a faster growth is needed (Thompson, 2023).

In the context in which renewable energy must represent almost all of the energy introduced into the national systems of all European Union countries by 2050, their volatility represents a problem that must be solved urgently. In the case of wind energy, its integration into the system involves major challenges for the safety and stability of the power system, which must operate within normal technical parameters and also be economically viable. (Liu et al., 2019).

It is necessary for an energy system to be balanced by the national transmission operators, so that everything remains stable. The energy used for this activity can be acquired from internal sources or it can be imported from neighboring states, but in many states the purchases of energy for balancing are made through auctions on the free market, leaving room for speculation by producers which aim to obtain additional profits (Maekawa & Shimada, 2019;

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Ehrhart & Ocker, 2021). The stability of the energy market is essential for all other economic sectors because shocks felt in it also affect other areas, such as industry and agriculture (Aiyetan et al., 2021).

A possible solution so that the percentage of the energy mix occupied by renewable sources can continue to increase until climate neutrality is reached in Europe is to increase the forecasting capacity of production. For this, Lau & McSharri (2010) were able to demonstrate that wind power production could be predicted minutes ahead using ARIMA and GARCH models.

Heteroskedastic models were also successfully used by Shen & Ritter (2015), who demonstrated the utility of the MRS-GARCH submodel in wind power volatility estimation. Their study showed that GARCH models can be useful for renewable energy investors to calculate and manage the financial risks in the energy market generated by weather conditions. The need to identify wind energy production forecasting solutions was also emphasized by Tastu et al. (2014), who were able to formulate some probabilistic forecasts for a 165 MW wind farm in Denmark.

Zhou et al. (2021) showed that due to the high contribution of energy markets to the global economy, events occurring within them have major implications on other markets. In this context, the volatility recorded in the energy markets also extends to the financial markets, which are directly influenced by the price of energy. This problem must be known and analyzed by the decision-makers of the states and the actors in the market in order to be able to prevent the risks to the financial systems.

Efimova & Serletis (2014) consider that GARCH models have become indispensable for modeling the short-term volatility of energy prices due to the efficiency shown. Therefore, they have already made their place in the analyses related to the energy market. Moreover, Ghosh & Gupta (2021) consider that correct forecasting by using heteroskedastic models can considerably improve electricity costs by planning the production surplus.

Li et al. (2023) used GARCH method to model the returns of green and conventional energy stock indices, demonstrating that climate risk factors (climate policy uncertainty, climate change news, and negative climate change news) increase the long-term volatility for brown energy, but does not affect the renewable energy. So, even if they receive negative inputs about the renewable energy sector, investors still choose to support this market.

As far as Romania is concerned, the national policies in the field of energy have fully aligned with the European ones, especially due to the available opportunities to increase the share of renewable sources in the national production. In this context, in the coming years an increase in the importance of the Black Sea offshore plateau owned by Romania is expected. It has more favorable wind for the installation of wind turbines than the onshore areas where wind farms have been built so far (Onea & Rusu, 2019).

According to studies carried out by The World Bank Group (2019), the entire coastal area of the Black Sea offers a good potential for the development of wind farms, the wind speeds being favorable, on average 7-8 m/s. In addition, the investment costs for these projects have also decreased over the last 10 years. In 2015, the levelized cost of energy in the case of offshore wind farms projects was 150 to 200 USD/MWh. In 2019 this indicator was below 50 USD/MWh, which was less than coal and nuclear projects.

In addition, Nedelcu et al. (2023) claims that although the offshore area of the Black Sea usually presents difficulties for the installation of wind farms, such as meteorological instability and large variations in wind speed, its western coast presents more favorable characteristics for the installation of turbines. The region, in which Romania is also located, has constant and moderate-strong speeds, which are good for investments in coastal wind energy production capacities.

Maniatis & Milonas (2022) show, using the GARCH-in-Mean model, that the degree of penetration of the national energy system in Greece by renewable energy has a significant impact on prices on the wholesale market, with a strong order-merit effect being found in their case. Thus, during peak hours, the wind energy contributes to price reductions. Separating the production of photovoltaic and wind power, it was found that the former tends to reduce the market price volatility, while the latter increases it because it is more unstable. The impact of the volatility of renewable energy production on market prices was also studied by Jonsson et al. (2010) on the Danish market by using a non-parametric regression. The results show that forecasts for green energy production cause price drops.

Also, Rintamaki et al. (2017) show, using a SARMA model, that in Denmark electricity price volatility on the day-ahead market is lower when wind power production is higher, while in Germany the effect is opposite. However, in both cases the price is lower when the energy production from the two renewable sources is higher, once again the order-merit effect being observed.

3. Methodology

The data used to calculate the volatility of wind energy production are taken from Transelectrica, the company that manages and operates the electricity transmission system in Romania. They are updated approximately every 10 - 12 hours and totalized 1403 values. The data used in the research are freely available and obtained from the internet page of the mentioned operator, where the electricity production is classified according to the production sources (hydropower, biomass energy, nuclear power, energy from hydrocarbons, wind power, solar energy).

In the graph in Figure 1 it can be observed the representation of these values and the considerable fluctuations of the energy production from the wind farms.

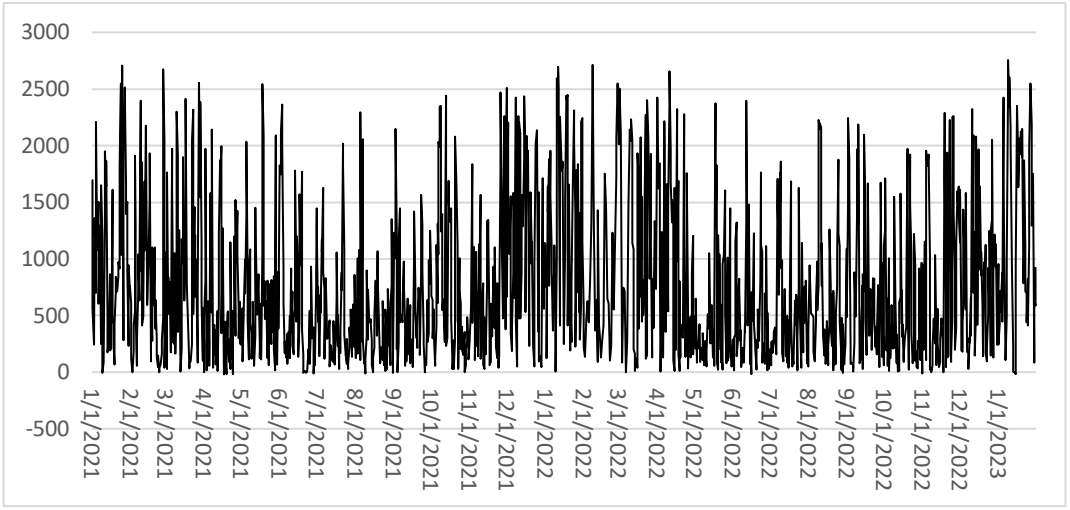

Figure 1. Wind farm energy production graphic in the analysed period.
Source: (Author's construct based on Transelectrica's data)

To avoid any trends in the analyzed time series, since it must be stationary in order to successfully apply the EGARCH model, the first difference function was used (the changing the value of the series from one point to the next point), according to the formula:

$$y = y_t - y_{t-1} \quad (1)$$

Where y_t and y_{t-1} represent the consecutive terms of the time series representing wind energy production, and y is the term of the time series resulting by applying the first difference function. Thus, the evolution of renewable energy production from Romanian wind farms is illustrated in Figure 2.

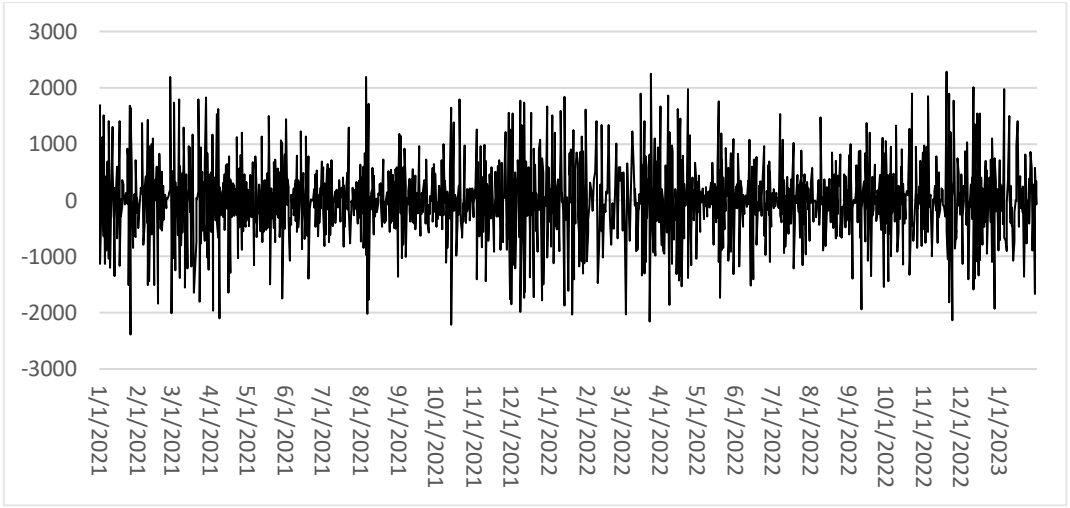

Figure 2. First difference function of wind farm energy production in the analysed period
Source: (Author's construct based on Transelectrica's data)

For the mathematical verification of the stationarity of the resulting time series, the Augmented Dickey-Fuller Test was applied, which tests the hypothesis that there is a unit root in the analyzed series. If the probability that this exists is below 0.05, it can be concluded that the time series is stationary.

Subsequently, to confirm that the time series has ARCH effects so that the heteroskedastic model could be applied, the ARCH test was used. Its null hypothesis is that the time series has no first level ARCH effects. If the probability for the null hypothesis is below 0.05, the heteroskedastic model can be applied.

The Exponential Generalized Autoregressive Conditional Heteroskedastic Model (EGARCH) was first introduced by Daniel Nelson in 1991 as an adaptation of the Generalized autoregressive conditional heteroskedasticity model (GARCH) developed by Bollerslev five years earlier. The main advantage of the model chosen for the present paper over other autoregressive models is the lack of restrictions on the parameters, since logarithmic variances are introduced in the equation instead of simple variances, which always have positive values. The formula used to express the EGARCH model is as follows:

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$$\ln(\sigma_t^2) = \omega + \beta \ln(\sigma_{t-1}^2) + y \frac{u_{t-1}}{\sqrt{\sigma_{t-1}^2}} + \alpha \left[\frac{|u_{t-1}|}{\sqrt{\sigma_{t-1}^2}} - \sqrt{\frac{2}{\pi}} \right] \quad (2)$$

After applying the EGARCH model, to test the results, it was generated the correlogram (up to threshold 36) to check for possible autocorrelation and there were performed the Engle-Ng Sign-Bias Test to identify the possible presence of leverage effects in the standardized residuals and the Nyblom Parameter Stability Test to identify possible structural changes in the time series. Subsequently, ARCH LM Test was used to check whether the residues still exhibit ARCH effects.

In addition, to analyze the impact of the wind energy subsector on the entire national energy system, the correlations between wind energy production and total energy production, energy exports and imports, and energy available for balancing (conventional sources and imports) were calculated.

4. Results

The Augmented Dickey-Fuller test, applied in Table 1, shows that the time series is stationary, being suitable for the application of the EGARCH model, if it presents ARCH effects, because the absolute value of the t-Statistic (19.83216) is higher than that of the critical levels (1%, 5% and 10%).

Table 1: Augmented Dickey-Fuller Test

Test critical values	t-Statistic	Probability
Augmented Dickey-Fuller test statistic	-19.83216	0.0000
1% Level	-3.434838	
5% Level	-2.863410	
10% Level	-2.567814	

Source: (Author's construct)

The testing of ARCH effects (Table 2) shows that the F-statistic is significant, because the probability F is 0, a situation in which the conditions are met for the null hypothesis, according to which the series does not present ARCH effects, to be rejected. Thus, the heteroskedastic model can be applied.

Table 2: Heteroskedasticity Test (ARCH)

F-statistic	Prob. F	Obs. R-Squared	Prob. Chi-Square
177.7540	0.0000	157.9656	0.0000

Source: (Author's construct)

The application of the EGARCH model on the analysed time series, as shown in Table 3, indicates a high volatility of wind energy production across the country, comparable to risky financial indices such as virtual currencies, a situation that creates uncertainties in the energy market and entails negative implications such as price increases or purchase of conventional energy for balancing from non-EU countries.

Table 3. EGARCH model

Variable	Coefficient	Probability
C(1)	0.9057	0.0000
C(2)	-0.0549	0.0000
C(3)	0.4819	0.0000
C(4)	0.9362	0.0000

Source: (Author's construct)

According to the results in Table 3, the ARCH term, C(2), is significant (p-value = 0), so the size of the shock has a significant impact on the volatility of the renewable energy production. Moreover, C(2) is negative (-0.054), so the relation between the past variance and the current variance in absolute value is negative. Under these circumstances, the bigger shocks to the variance doesn't necessary determine a higher volatility.

C(3) is positive, so the series has no leverage effects. In this context, there is not a negative correlation between the past return and future volatility. Also, the bad events (so named bad news), like low winds, does not necessarily have a bigger impact on the volatility than the, so called, good events (strong wind). That happens because in the analysed period we didn't face very much frost on the airscrews (the weather was very hot in the last years). This is de

difference between energy and financial series. The wind power production is objective and doesn't care about how the weather was last time when the production dropped.

Also, the C(4), which is the GARCH term, shows a very high persistence (0.9362) of past volatility. Because its p-value is also 0, it is possible and reliable to predict future volatility based on past volatility.

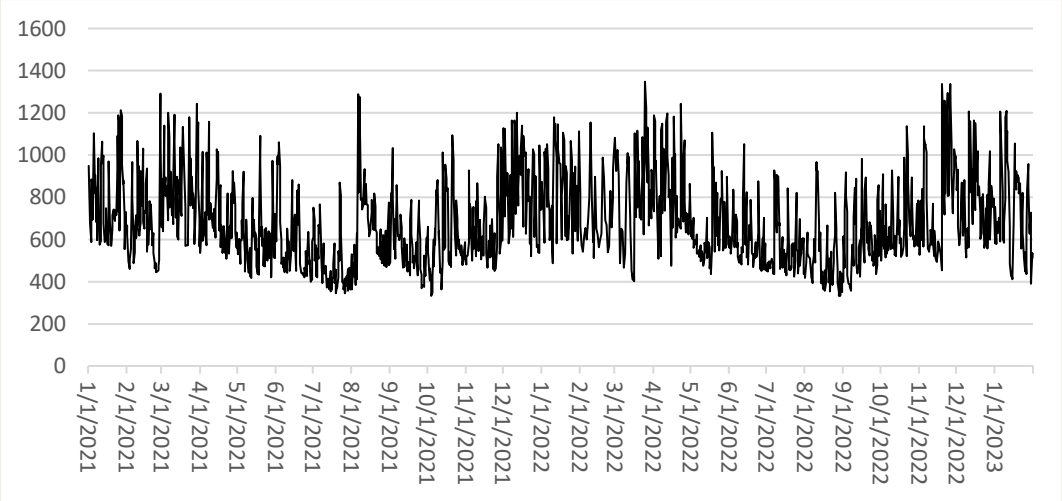

Figure 3. Conditional standard deviation
Source: (Author's construct based on Transelectrica's data)

For a better visual observation of the results, conditional standard deviation was also generated after applying the EGARCH model on the data series (Figure 3).

Table 4. Tests

Test		**Probability**
Nyblom Parameter Stability Test	1% Crit.	0.748
	2% Crit.	0.470
	3% Crit.	0.353
Engle-Ng Sign-Bias Test	Sign-Bias	0.2964
	Negative Bias	0.2794
	Positive Bias	0.9794
	Joint-Bias	0.6122
ARCH LM Test	Prob.	0.5665
Correlogram	Prob. (36 lags)	[0.544;0.973]

Source: (Author's construct)

Nyblom Parameter Stability Test shows probabilities greater than 0.05 for all three critical thresholds, indicating that the parameters are stable. Also, when applying the Engle-Ng Sign-Bias Test, all probabilities were greater than 0.05, which means that the model is well specified. The ARCH LM Test showed that the residuals no longer exhibited ARCH effects, with the F-statistic being greater than 0.05. Finally, performing the correlogram for 36 lags it resulted that there was no serial correlation.

Table 5. Correlations

	Wind power
Imports	-0.530
Exports	0.530
Production	0.703
Equilibration	-0.518

Source: (Author's construct)

Analysing the correlation between wind energy production and total energy production at national level, the value of 0.703 was found, which indicates a strong dependence of the national energy mix on wind energy. In addition, a correlation index of 0.530 was found between wind energy production and exports and an inverse correlation of -0.530 between wind energy production and imports, indicating that when wind energy is produced, Romania can export energy, while when production decreases, imports will be necessary. These values already show the high

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dependence on wind energy of the national energy sector, which must increasingly include this source. A similar dependence is also revealed in the case of the energy trade balance. On the other hand, wind energy producers are also dependent on exports, as they ensure the continuity of production when there is not enough demand in the domestic market.

The results of the EGARCH analysis are also doubled by the inverse correlation (-0.518) between wind energy production and energy used for balancing, meaning that when wind farm production decreases, there are not enough other renewable energy sources to compensate the shortfall, which is why conventional capacity and imports need to be used. This is the main shortcoming of renewable energy sources, because in order to be balanced, systems that include them in large proportions still depend on stable sources of energy, which are usually polluting.

Since the use of renewable energy sources takes precedence in the national energy mix, wind energy dictates the 4 correlation values with the indicators mentioned, so that we can speak, in practice, about an influence of wind energy production on them and not vice versa. So, wind power determines how much conventional energy will be needed into the system, while European countries shut down polluting generating capacity. This leads to the need to import polluting energy from third countries, which are not subject to the European Green Deal and use the EU as a destination market for the surplus energy in their system.

5. Conclusion and Recommendations

As in other cases where heteroskedastic models have been applied to estimate the volatility of renewable energy production (Lau & McSharry, 2010; Shen & Ritter, 2015), the EGARCH model also performed well, indicating high volatility in the evolution of wind energy production over the period under analysis. The statistical tests applied also confirmed the correctness and efficiency of the model and show that forecasts can be made with confidence based on it.

The present study clearly shows that renewable energy production is highly volatile. At the same time, the results of the heteroskedastic models applied by Maniatis & Milonas (2022) show that wind energy causes a reduction of energy market prices in times of scarcity but increases its volatility. On the other hand, Rintamaki et al. (2017) show that prices are less volatile in Denmark when wind power production is higher and Jonsson et al. (2010) show that renewable energy drives down energy prices in this country.

In this context, it should be noted that the impact of renewable sources on the price of energy depends on the structure of the energy mix - which is specific to each country - but its impact on the actual energy production is a constant and objective element, which is different from the impact on energy market prices.

By correlating the values recorded for wind energy production with production from other sources, whether conventional or renewable, as well as with indicators such as sources suitable for balancing market entry (due to in-band energy production), it was found that the efficiency of wind farms already has a large impact on the national energy market. To a significant extent, it dictates a significant part of the import requirements, export capacity and balancing requirements in the national energy system.

This comes with both advantages - as wind farms contribute fully to achieving the objectives of decarbonization of the economy, helping to meet the environmental standards assumed by the Romanian state in relation to European authorities - and disadvantages. The latter consist mainly of the increased instability of the national energy system, the increase in prices on the balancing market due to the even higher demand and the risk of having to resort to energy imports from neighbouring countries, often produced from conventional and polluting sources, a situation which would mean that the objectives of the Green Pact would only be achieved fictitiously, with the energy used in reality still being polluting, but produced outside the European Union.

The results of the application of the EGARCH model show its efficiency in the analysis of energy production and illustrate the high volatility of wind energy production, and the correlation between it and the other monitored indicators shows the ability of this sub-sector to influence the entire energy market.

However, a limitation of the study is that the analysis was carried out over a long time period (2021-2023). The accuracy of the results could be better if the model was applied several times for data from consecutive, shorter periods. Wind farm output fluctuates, but this fluctuation is different from period to period, depending on the different climatic conditions from season to season, which provides a minimum degree of predictability for operators.

It should be noted that the paper does not aim to highlight only the weaknesses of wind energy or to condemn the boom in the renewable energy industry, but to highlight the current shortcomings in the energy system and to contribute, as far as possible, to the identification of solutions to address them. In this way, grid integration and further development of green energy production capacities would be achieved in a healthy and efficient way and would not lead to a decrease in the quality of supply services or to higher prices for end consumers.

The results of the application of the EGARCH model on the analysed series show that the volatility of energy production from wind farms is also very high in Romania, although they are located in some of the most favourable areas of the Black Sea Region, such as the Dobrogea area or the Curvature Carpathians, with winds above 7 m/s, often exceeding 9 m/s (World Bank, 2020; Gârleanu et al., 2021, Zaides et. al, 2001).

This volatility increases prices on the balancing market and leads the system operator to resort to imports when the energy produced is not sufficient to meet the consumption level. In the case of Romania, imports mostly come from Ukraine and represent the electricity produced from conventional energy sources, as shown in Table 5. Also, as

Zhou (2021) argues, volatility propagates to other markets, such as financial markets, whose fluctuations are strongly influenced by energy market events.

In addition, the need to keep the system within normal parameters by using conventional generation capacities cannot achieve climate neutrality, as polluting sources are still indispensable for balancing in the current energy mix structure. One solution to their replacement is to increase the degree of interconnection of national energy systems, while increasing renewable energy production capacity and diversifying them, similar to reducing financial risk through portfolio diversification. So that, when climatic conditions are not favourable for energy production in one region, it can import green energy from another, and when one has a surplus of production, it can export it.

In markets where traded energy is produced in high percentages from wind farms, its volatility is also considerably reflected in the price (Maniatis & Milonas, 2022), in periods of favourable wind they are lower as the market is oversaturated and when production decreases, prices increase. A possible solution to this phenomenon is to create capacity to store the excess electricity in other forms, such as the creation of green hydrogen. This would reduce the price volatility, as in times of surplus the surplus can be converted into hydrogen that could be used in times of deficit, keeping production constant.

Another solution that needs to be encouraged is the installation of off-grid and on-grid renewable energy generation capacity directly by end-users (such as photovoltaic panels on houses and blocks or wind turbines). These can support a significant share of household consumption, reducing the demand from the centralised market, especially at peak times and thus reducing the energy prices. In addition, the installation of production capacity directly at the point of consumption also reduces the investment costs with the development of the transmission and distribution networks.

European policies aimed at achieving climate neutrality by 2050 focus heavily on financing projects of building renewable energy generation capacities, but do not focus as much on the solutions needed to integrate them into the system, leaving most of this responsibility to transmission operators. Sometimes this even prevents the development of new wind or photovoltaic plants, with investors having to abandon or postpone their projects because they cannot connect them to the power transmission system.

The development of renewable energy volatility forecasting solutions is necessary to prevent blackouts and maintain the quality of supply to end customers. The EGARCH model can be effective for this task due to the lack of restrictions on the parameters, which are always positive, since logarithmic instead of simple variances are introduced in the equation. Although heteroskedastic models can still be improved, their usefulness for modeling and predicting the volatility of renewable energy is certain, and in the future, they will play a considerable role in balancing electricity transmission systems around the world.

For future researchers it may be useful to apply heteroskedastic models over shorter time periods for data updated to the minute, so that their effectiveness for lower fluctuations can be tested. Subsequently, short-term forecasts could be made based on past volatility of output. Furthermore, the application of heteroskedastic models could also be tested separately, on all renewable sources of energy and for short periods, so that forecasts can be made and the energy mix can be modelled in advance so that balancing the system can be done more easily.

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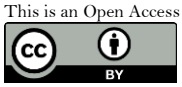

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Corporate Governance, Corporate Social Responsibility and the Corporation's Purpose[1]

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ABSTRACT

Purpose:
To rethink the idea that corporate governance is about the alignment of interests of all stakeholders. To indicate this idea's main problems, in making the manager's job significantly more difficult, and in creating numerous avenues for managers seeking merely to advance their own interests. To look into corporate social responsibility in the light of value rationality, and to understand that taking into account stakeholders' interests may be extraneous to purpose rationality and to the corporation's purpose. To indicate this main difference between a corporation as a juristic person of limited purpose on the one hand, and a state government on the other. To relate these ideas to Freeman's "new story of business" and to the declaration that profits are an outcome of successful business rather than its purpose.

Design/methodology/approach:
The approach is conceptual/ philosophical.

Findings:
The stakeholder theory of corporate governance is misguided, insofar as it is taken to assume that the purpose of the corporation is to serve the various interests of all stakeholders. Considerations of corporate social responsibility may (and should) be understood as value rational, having little bearing on the corporation's purpose, i.e. shareholders' profit, but placing essential constraints on the means of its achievement. This however should not be seen as being at odds with Freeman's "new story of business".

Research limitations/implications:
The "stakeholder theory of corporate governance" may be construed (in light of the above) as placing the interests of stakeholders other than the shareholders, outside the corporation's purpose. History may result in corporations taking over parts of government, thus integrating common good in the corporations' purpose from a normative point of view.

Originality/value:
The application of the distinction between value rationality and purpose rationality, to what CSR means for the purpose of the corporation and for stakeholder theory, is totally original, and so is the main conclusion of the argument.

Summary:
The original core problem of corporate governance is the agency problem and the alignment of interests between managers and shareholders, under the principle that the purpose of the corporation that managers ought to serve is shareholders' profit. The idea of corporate social responsibility has brought about stakeholder theory, that is the idea that corporate governance is about serving all stakeholders' interests. This multiplies the conflicts of interests to be aligned and creates in effect many more avenues for managers seeking to advance their own interests. We present an example of a board of directors seeking to allocate a substantial part of the corporation's wealth to the alleviation of social poverty, and we revisit the question of the purpose of the corporation as a legal boundary to the possibilities of the juristic person that is the corporation. We advance the idea that corporate social responsibility and taking stakeholders other than shareholders into account is about value rationality, not purpose rationality, and should not be understood as necessarily

[1] The present study has been presented at the 15th International Conference "Economies of the Balkan and Eastern European Countries", EBEEC 2023, Chios, Greece (http://ebeec.ihu.gr).

depending on long term profit or any win/win situations. It mostly places constraints on the purpose rational means to achieve the corporation's purpose, which remains shareholders' profit. It must not be understood to alter this purpose, nor to make the corporation assume a social role paralleling state government. Freeman's advocacy of the "new story of business", and his concomitant ideas that business is about the business idea rather than profit, that people are not primarily driven by greed, that stakeholder relationships are crucial for business, and that creative imagination in balancing all values and interests is at the root of greater value creation, are in fact perfectly reconcilable with the above.

Keywords:
Corporate Governance, CSR, Stakeholder Theory, Value Rationality, Purpose Rationality

1. Introduction

Whenever I say that I teach business ethics, or corporate social responsibility, I invariably get this response: "Is there such a thing?".

And I often respond by invoking the distinction between the descriptive and the normative disciplines. Business ethics is a normative discipline; it is not about what is, but about what ought to be. Responsibility, and accordingly corporate social responsibility, is a normative concept.

Corporate governance is also normative. It is, incidentally, interesting in this respect, for it starts by being descriptive (practices and procedures of running a corporation) and ends in being normative (practices and procedures of running a corporation efficiently, to achieve its objectives). Although we can of course still speak of "corporate governance" descriptively, distinguishing it from "good corporate governance", the academic discussion on "corporate governance" is not in fact concerned with describing how actual corporations happen to be governed, but with seeking to determine how an ideal corporation is to be governed, thus prescribing rules of governance that actual corporations are to follow.[1]

So corporate governance, and corporate social responsibility, which are our topics here, are both normative issues. However, if you search Google for articles on corporate social responsibility and corporate governance, you'll be confounded by empirical research; it will be harder to find normative papers.

In this conference too, empirical research abounds. Even in this here working group, on "corporate governance, CSR and ESG", there are hardly any papers with a normative point of view.

Admittedly, I am not good for empirical research. I will invite you therefore to shift your focus for a little while, and to discuss with me, not what is, but what ought to be.

2. Corporate governance as a matter of alignment of interests

The academic discussion of corporate governance begins with the agency problem; i.e. the probability that the agent, who is supposed to act for the interest of the principal, has his or her own interest, which is at variance with the principal's interest. (Gstraunthaler et al, 2008). This problem is inherent in the structure of the corporation, with managers managing financial resources provided by the shareholders. What is to stop the managers from acting in their own interests and against the interests of the shareholders? So, from a classical economist's point of view, the idea of corporate governance is mainly about minimizing (if not eliminating) the conflict of interest between managers and shareholders. Or, more accurately, it is about aligning the managers' behaviour with the shareholders' interest, despite the managers' interest being at odds with the latter. For the managers are naturally assumed to ought to serve the shareholders' interest, as agents for the shareholders, in accordance with the idea that the purpose of the corporation is to achieve profit for the shareholders.

This traditional idea, that the purpose of the corporation is to achieve profit for the shareholders, was clear, simple, concise, and suitable as a driving idea, in purpose rationality, to lead to logical conclusions. And it provided a relatively simple test whether the managers did their job.

However, corporate governance nowadays is not only about that. It is also about corporate social responsibility, and about the interests of the stakeholders.

Indeed, the idea of corporate social responsibility had a profound effect on the idea of corporate governance. This is because it brought about a radical shift in the theory of the corporation, regarding its purpose.

The root of the idea of corporate social responsibility was a social demand, that meant a moderate at first limitation: the pursuit of profit must not destroy society. This came with a logical justification: the corporation, and the managers, have a duty to society too. Society has a variety of constituents. And this led to the stakeholders; these

[1] This is actually quite instructive for the concept of ethics too, and its history, which is obviously rooted in the prima facie descriptive idea of habits (mores → morality, ἤθη → ἠθική, and also Sitte → Sittlichkeit).

are also important, on a par with the stockholders. So now, the duty of the managers' is not only to these, but also to customers, workers, and so on.

This is stakeholder theory. According to it, good corporate governance is governance serving all constituents' interests. It is of course still about efficiency, but efficiency to achieve what? Profit for stockholders of course, and cheap but quality products for the consumers, and good pay and humane conditions for the workers…

Do these interests, and purposes, align?

They may. Managers' talk these days is full of "win/win" situations, and "doing well by doing good". But what if they don't? For one would expect to see conflict rather between these interests, and their alignment to be an exception. However, this conflict is conspicuously missing from managers' talk, or from business administration literature.

If we return to the original idea of good corporate governance, which sought to address the conflict between the shareholders' and the managers' interests, we now see that we have multiplied the relevant interests and the conflicts between them. Consequently, it seems to me, that, where the good manager is concerned, we have made his job immensely harder. But where the wicked manager is concerned, his work has become much easier; because in seeking to pursue his personal interest rather than any other stakeholders', he can always find some stakeholders' interest to advance as the rationale for his decision. There is indeed always a win/win situation for him, where the one "win" is his own profit.

3. An imaginary example

So, I will ask you now to imagine a situation, where conflict between interests is at the forefront, rather than hidden in the margins. In the middle of a dire economic crisis, with unemployment on the rise, war caused shortages and natural disasters on top of it all, let us assume a for-profit corporation that has not been hit by the disaster. It is doing very well financially, not only because it happened to make certain choices in the past that turned out well, but also because a great part of its clientele are the obscenely rich, who were not touched apparently by the crisis. And let us assume a suddenly enlightened board of directors, who have decided that, now that society needs it, they want to give. A lot. Not because long term profit is thus expected, but because it is in accordance with their and the corporation's social responsibility. E.g. to alleviate poverty. So, they seek to allocate, say half the corporation's last year's earnings, to this.

Would this be good corporate governance? It would be great state governance probably, as the seven fat cows, seven lean cows ancient myth teaches us; but can we say this in the context of the for-profit corporation? And if not, why not? Aren't the people of society stakeholders too, whose interests the corporation and the corporation's management ought to serve?

Milton Friedman would have repudiated such a proposal, as totally irrational, and even deeply unethical, being an embezzlement in effect of the shareholders' money. It would most certainly be about spending other people's money. But what if the proposal came not in the board of directors, but in the shareholders' assembly? Could this be decided by a majority vote? Shouldn't the minority be allowed to veto such a decision, on the grounds that it is outside the corporation's purpose of existence? But we just said that, in stakeholder theory, this purpose has come to embrace, not just stockholders' profit, but the interests of all other stakeholders too.

Notice here that the actual burden of such a decision to each shareholder would depend on this shareholder's particular circumstances. It would depend for instance, on what percentage of this shareholder's wealth happened to be tied to this corporation; or on the time that this shareholder had planned, or needed, to liquidate. It is conceivable therefore, that there might be shareholders for whom such a decision might amount to economic ruin. It is also quite conceivable, that this decision might be in the actual personal interest of a CEO or controlling shareholder (or both), who just happened to be running for President of the USA.

4. The corporation as a juristic person in law and legal theory

The question whether a decision and a course of action such as this should be possible for a corporation to take is primarily a question for law and legal theory. And it is tied to the more general question what sort of actions a corporation is allowed to take and what sort of actions it is possible for a juristic person to take. Economists may perhaps be excused for having a blind spot, or perhaps a disregard even, for the legal fact that the corporation is a juristic person with its own rights and obligations, which are neither the ones of the stockholders', nor of anybody else's inside the corporation. However, the question whether the managers, or the shareholders may vote towards e.g. allocating a substantial part of the corporation's wealth towards the alleviation of poverty, is first and foremost a question regarding the boundaries of the juristic person itself in general, and of the for-profit corporation itself in particular.

From the point of view of legal theory, this last question about the boundaries of a juristic person is tied to the old question regarding the nature of the juristic person, that was hotly debated in the 19th and the early 20th century, at the time that is of the establishment of the corporation as the dominant institution in economy that we know. The practical impact of that debate (which impact was admittedly forgotten in later times) was precisely the extent to which a juristic person, and therefore a corporation too, may seek to take a course outside the scope of what was established or understood to be its role in accordance with its charter, or even the extent of what was possible for a charter to stipulate.

This debate died out, having led to ideas that were conducive to greater freedom for corporations to act, and less boundaries on their (and their managers', or, at any rate, shareholders') possible decisions. Indeed, the idea seems to have more or less prevailed in legal theory long ago, that juristic persons should be conceived of as real organisms, that are not in effect restricted by their artificiality (if indeed it be thought of as artificiality) in having virtually all

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sorts of rights and obligations. Positive law, for the most part, seems to have allowed for this, throughout most, if not all, legal systems. Interestingly though, in virtually all domestic legal orders, a provision remains regarding the corporation's (or any juristic person's) purpose, which is to be stated in its charter, and entails some boundaries regarding the legality of the managers' or even possibly the shareholders' decisions. With respect to the for-profit corporation, it is normally understood that this purpose is tied to the idea of the achievement of profit, whose beneficiaries are of course the shareholders, each one according to one's share. However, stakeholder theory has had an impact to this as well, with the effect that the idea tends nowadays to be added sometimes, that the legal purpose of the corporation is also to include the various stakeholders' welfare. (British Academy, 2021; Mayer, 2022).

5. The corporation's purpose. Purpose rationality and value rationality.

Still, it seems to me that there is much to be said in favour of the clarity of the original, if out of fashion, driving idea of corporate governance, that the corporation's role, and the corporation's managers' primary duty, is towards the interests of the shareholders. Not in the sense that the interests of other stakeholders should not be taken into account in corporate management, but in the sense that we need a rational standard regarding the managers' mission, that is clearer than stakeholder theory.

We may perhaps find this rational standard if we remind ourselves of the distinction between purpose rationality and value rationality. And also, of the distinction between one's purpose and the efficiency in achieving it, and the constraints and duties that may exist for reasons other than this purpose.

The distinction between purpose rationality and value rationality is normally attributed to Max Weber and his work (Weber, 1922; 1978). Purpose rationality (Zweckrationalität in the German original) is deciding and acting because of a purpose that will be served by the action. It is contrasted to value rationality (Wertrationalität in the German original), which is deciding and acting because of a value that the action itself has. If I am writing a book because I have something to say and I want to express myself, my action is value rational. If I am writing it, so as to finally achieve full professorship, my action is purpose rational. If I am listening to a song, because it is beautiful, I am being value rational. If I am listening to it, in order to learn to sing it, e.g. for tomorrow's talent show, I am being purpose rational. The workings of the corporation towards profit for the shareholders are purpose rational actions.

So, what about the idea that a corporation should also take into account the interests of the stakeholders? What about the effort of the corporation to stand up to its corporate social responsibility?

I would ask you to consider with me the idea that responsibility, and so corporate social responsibility, is not primarily about purposes; it is about values. Responsibility in redressing a wrong that I have done, in seeking to be honest in my transactions, in being there for my students, is not about achieving something else, that is extraneous to my conduct; it is about the value of the conduct itself. To be clear, there may well be numerous goals to be reached through this responsible conduct as well; in redressing the wrong I may also avoid retribution, in seeking to be honest I may nurture a profitable relationship for the future, in being there for my students I may hope for their positive evaluation. However, my conduct is equally responsible or irresponsible, regardless of my attempting to reach these goals or not. From the point of view of purpose rationality, if there is no fear of retribution, there is no reason to redress the wrong that I have done; if I will never see the other guy again, there is no reason to be honest towards him; if I intend to quit my job tomorrow and go live in a Thibet monastery, there is no point in being there for my students today. But these considerations have no bearing to the question whether I acted responsibly or not, nor to the issue what my responsibilities were. For these are a matter of value rationality.

Accordingly, I would suggest that corporate responsibility to society, and to stakeholders, is not about seeking to serve their interests, in order to create more value for the company, or because their interests somehow have a place in the company's goals; it is about the fact that harming them (in order to achieve profit) is wrong. Perhaps it is better to say, not that there are stakeholders, besides stockholders, whose interests the corporation ought to serve too (purpose rationality), but that there is the corporation with its stockholders in the pursuit of profit which is the goal in running a company (purpose rationality), and at the same time there are constraints in the ways of reaching this goal, because of the value that is placed on workers, customers, the natural environment, etc. (value rationality).

I may be driving to a destination; reaching it is my goal. And I may be driving fast, to avoid being late. Still, I must, and I will, make sure that I do not kill that kid who is crossing the road. The kid's life is much more important than my reaching my destination in time. This however does not make the kid and its life my goal; my goal remains my destination.

It is the same with the stakeholders. It is not about how important they are vis a vis the shareholders. Workers may indeed be much more important than shareholders' profit, same as the kid while I was driving. This does not make their welfare a goal of the corporation. The corporation's purpose remains the (less important) profit, in accordance with its specific type of business.

Accordingly, for the most part, corporate social responsibility as well as the welfare of the stakeholders is normally a reason not for positive action, but for refraining, in the pursuit of shareholders' profit, from otherwise efficient profit seeking action, that would damage society and the corporation's stakeholders. However, this should not be taken to mean that corporate social responsibility and consideration of values are solely about constraints and refraining from action. Positive action may be entailed through value rationality in this context too. If while driving I encounter the kid wounded (because run over by someone else), I may be obliged, and I will certainly be justified, to stop and help, thus delaying my reaching my destination. My purpose, my destination, has not changed. There's simply a (greater) value – the kid's life – that takes precedence. On the same footing, if the democratic state, of which the corporation may by analogy be understood to be a citizen, decides to require the corporation to divert its profits to address an exceptional emergency, it may be the corporation's duty to actively involve itself accordingly (rather than drag its

feet, or seek ways to avoid it), thus postponing for the time being the achievement of profit. Or, if through the corporation's negligence, a disaster has hit the vicinity of its factories, it may be the corporation's obligation to do everything in its power to alleviate these consequences, rather than mainly seek to cut its losses.

In any case, an important general point to make is that the justification of the corporate socially responsible attitude does not depend on attaining profit through it, or in parallel with it. It is not about win/win. It is primarily about respecting values other than profit. However, respecting values other than profit does not make these into a goal of the corporation. Taking into account the importance of the corporation's stakeholders does not entail that promoting their interests is a goal of the corporation and its managers. Under normal conditions, the sole job of the managers' is to achieve profit for the shareholders, through the business that has been stipulated in the corporate charter; with the caveat that, because of social responsibility, the means to achieve this profit, the means of doing this business, may not entail the harm of society.

So let us return now to our example of the enlightened board of directors seeking to allocate the corporation's resources in the alleviation of poverty. The above should have made clear why such a course of action cannot be reasonably justified by the idea of corporate social responsibility, or by the idea of the importance of stakeholders other than shareholders. Unlike the government, the corporation has no responsibility to alleviate poverty. It seeks profit – not the welfare of the people – but while valuing the welfare of society in which it operates, and thus having a responsibility to refrain from harming it.

Furthermore, it is important in legal theory to revisit the old and forgotten question what a corporation is, in the sense of juristic person. And perhaps to restate the idea that there are limits to what it can and cannot do, as a matter of its artificial nature as an aggregation of capital, or union of persons, serving a limited purpose, which is profit for the shareholders.

At least insofar as we want to keep corporations separate from state government. And unless of course we are fine with allocating society's government or parts thereof to corporations, i.e. to corporate managers.

6. Conclusions

From the above arguments it should follow that the stakeholder theory of corporate governance is misguided, insofar as it is taken to assume that the purpose of the for-profit corporation is to serve the various interests of all stakeholders. The purpose of the for-profit corporation is shareholders' profit. This does not make it more important than considerations of corporate social responsibility, which are value, not purpose rational, and have little to do with the corporation's purpose. They may place constraints on the means of achieving this purpose, regardless of the possibility of alignment of interests. They do not depend on win/win situations and may be valid even if they entail less efficiency in or postponement of the achievement of profit; however, they cannot justify a modification of what the business of the corporation is. Finally, we should revisit the idea of the juristic person that is the corporation, and of the purpose of the juristic person as limiting in legal theory its possibilities of action.

7. Addendum. On Freeman's new story of business.

The stakeholder theory of the corporation is tied up to R. Edward Freeman's work. So much so it seems, that it is practically impossible to speak about this theory, without having to grapple with his writings. In recent years, Edward Freeman has been persuasively advocating a "new story of business" (Freeman, 2017), which is to be contrasted to the "old story of business", and which he argues is more suited to our times following the global financial crisis. Part of this new story of business seems to be a shift from the idea of profit as the business's purpose. This appears to be at odds with our argument here. In what follows I will try to clarify this issue.

Let me start by summarily saying that I am quite sympathetic towards Freeman's view that "profits are not the purpose of business", but rather an outcome of successful business. (Freeman, 2017, p.452-3). I would insist however that profits, through its specific type of business, are the purpose of any for-profit corporation.

The business idea is indeed primary in starting a (successful) business. And it may well be true that "most entrepreneurs start their companies because… "they are on fire about their business idea"". (Freeman, 2017, p.453). However, the entrepreneurs who are on fire about their business idea are not a for-profit corporation and are perfectly free to not create one. Once they have created a for-profit corporation, they are bound by the legal rules that are tied to this form of doing business, which is a juristic person that is separate from them, and which, unlike a human being, was of old conceived as limited in its purpose. These rules have traditionally rested on a cardinal distinction regarding whether the corporation is created for profit or not. This is so for many reasons, but crucially because through the corporation the entrepreneurs will turn to others, indeed to the public, for financing. And it needs to be clear whether the newly created organization is going to be seeking profit, among other things, or not; and whether the shareholders will be entitled to expect to receive profit through the corporation's business, or not. It was thus traditionally understood, on the very foundation of the legal rules instituting these organizations, that each shareholder has some sort of right, to expect that the for-profit corporation stay on a particular course, laid out in the corporation's charter, towards profit. And that the corporation, and its managers (and the shareholding majority too) are not at liberty to act in any way they like in this respect.

Accordingly, corporate governance is about rules entrenching roles within the organization. Rules that entail permissions and prohibitions. And roles according to which managers and employees are expected to act. So, is the role of the manager to pursue his or her own vision of the common good? Is the controlling stakeholder's role to choose any goal he or she sees as valuable? Or are managers and shareholders both, in these capacities of theirs, parts of an organization having a particular purpose according to its charter? According to traditional legal theory, the latter is true. And the real question here is, should we change this? Should we more specifically allow the managers to

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disregard, at least to some extent, this obligation to seek profit, in favour of the common good or of their vision of the common good – as this new story of business seems to advocate?

Freeman says correctly that it is wrong to think that people and companies are entirely self-interested, competitive and greedy. That people want meaning and purpose in their lives and are not merely driven by carrots and sticks. That the traditional in classical economics presentation of people as completely self-interested is flawed. (Freeman, 2017, p.456-7). However, the opposite claim, that people are never self-interested or greedy, is also patently wrong. The thing is that some people are mostly like this, and some people are mostly like that, and most people can be both at times. And although most people will try to do what's best most of the time (at least insofar as they need not work too hard, or sacrifice too much for it), there will always be those who will seek to exploit others for personal interest. Even though it is true that no one wants to be (categorized as) bad, this does not mean that there is no crime in the world; it simply means that the perpetrator will rationalize, or simply avoid confronting the moral implications of his or her actions. In shaping our institutions, we must allow for both eventualities; not rest on one simplistic idea about human nature's being either egoistic or altruistic. And when making rules of law, which are to help minimize conflict and to be used in adjudicating conflict, we have to primarily take into account the possibility of egoism and greed, which are often at the basis of this conflict. In making rules regarding the degrees of freedom that managers of corporations must have in managing other people's money, we have to take into account the fact that there are greedy managers too.

Still, it is the spirit of our times to allow for more and more freedom and power in the hands of corporate managers; and perhaps things will continue to turn in this direction anyway. The perfectly valid ideas of corporate social responsibility, and of the importance of the stakeholders, have also added apparently to this tendency. What I have tried to do here is to show that corporate social responsibility, and the importance of business ethics for every type of business, must not be assumed to necessitate this radical shift from traditional and – might I add – wise legal theory, in what regards the purpose of the for-profit corporation. And truly, I wholeheartedly agree with Freeman that "a sense of values and ethics has to go alongside purpose" (Freeman, 2017, p.461), merely pointing out precisely that values and ethics are not the corporation's purpose, they indeed go alongside purpose.

Is this idea of the separation of the purpose of profit (in purpose rationality) from values and responsibility (in value rationality) in tune with Freeman's "new story of business"? Does it allow for the idea of the importance for business of caring for stakeholder relationships and for the creation of value for all stakeholders? (Freeman, 2017, p.458). Of course, it does. Does it allow for the creative imagination that Freeman says may be utilized once trade-offs are unacceptable? (Freeman, 2017, p.459-60). Absolutely; and in a more radical manner too. Because understanding values as limits to the pursuit of (the purpose of) profit makes trade-offs between the two much more difficult to envision. However, we must add here, that understanding what is real and what is not, what is possible and what may be impossible, is not merely a matter of lack of imagination. It may well be, and often is, a matter of being able to look at the facts of life. When trade-offs are necessary, as, for all the imagination in the world they may well be, we need a clearer sense of each one's role and of what is most valuable, than is afforded by the win/win idea.

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Environmental, Social and Corporate Governance (ESG) on the Financial Performance of Listed Mining Firms in South Africa

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ABSTRACT

Purpose:
This study aimed to determine the relationship between the environmental, social, and governance factors (ESG) and the financial performance of mining firms within South Africa. Prior research has focussed primarily on the ESG components and lacked further investigation on the sub-components of ESG as it applies to specific sectors.

Design/methodology/approach:
Convenience and judgment sampling were used to draw a sample from a publicly available database. Based on a criterion for robust analysis, 13 of 41 JSE listed mining companies were selected. This study used a two-way random effects panel regression analysis to determine the relationship between ESG variables and firm financial performance on JSE-listed mining firms, in South Africa from 2008 to 2020.

Findings:
There was no statistical relationship between overall ESG score and firm performance. However, only the Governance score illustrated a statistically significant relationship with financial performance. Within the sub-components, the following had a significant negative relationship with firm performance: emissions; environmental innovation; working conditions; and shareholder responsibility. However, human rights and CSR strategy significantly positively correlated with financial performance.

Research limitations/implications:
This research was conducted specifically on South African mining companies, and therefore cannot be generalised to other industries or markets in developing and developed countries. Managers and policymakers within the mining industry should consider the practical implications and interpretations of the findings and may offer incentives to implement improvements regarding emissions, environmental innovation, and working conditions.

Originality/value: This research delved deeper into the sub-components of the ESG pillars to get a better understanding of each sub-component on firm performance.

1. Introduction

A firm's environmental, social, and governance (hereafter referred to as ESG) factors have become an increasingly important consideration for investors, shareholders, and business managers globally. Investors can use ESG factors to assess potential risks and opportunities for a firm to create long-term shareholder value. Further, managers can position their firms to account for the ESG requirements outlined by regulatory bodies and those particularly preferred by investors. ESG is a multidimensional factor that includes environmental concerns such as carbon emissions and sustainable material sourcing, social issues such as labour practices and product safety, and governance matters such as board diversity and tax transparency. The ESG challenges a company faces vary widely based on industry and company maturity; therefore, there is no one size or type which fits all (PWC, 2020).

According to Chartered Accountants of Canada (2010), there are five main reasons for the use of ESG information by investors, namely, e to inform risk and return potential, evaluate management quality, engage with companies and inform proxy voting, develop customised investment products or portfolios and assess asset managers.

Rating agencies determine a firm's ESG ratings by accounting for the firm's performance on various ESG components. The ratings are then adjusted to the characteristics of the firm's industry so that components can be weighted based on their relevance to the industry. The final score is expressed through a numerical scale and a letter ranking system (Farnham, 2020). A listed firm can thus disclose an overall ESG score and separate scores for the

three components that make up the overall score. A company's score potentially offers investors a more profound and precise analysis of a firm's performance, specifically concerning environmental, social, and governance concerns.

Consumer behaviour is changing, and consumers are shifting focus to increase sustainable consumption choices and decrease their negative environmental impact (MSCI, 2021). Changing consumer behaviour correlates with firm financial performance, as revenues may be linked to consumers' changing spending habits. ESG scores are becoming increasingly important to other stakeholders, such as suppliers and governments, and managers and investors need to account for this moving forward (Farnham, 2020). This increased importance of ESG considerations emphasises the need to understand the relationship between a firm's ESG scores and financial performance.

Previous research in developing markets by Dalal & Thaker (2019); Zhao et al. (2018) found a positive relationship between ESG and firm financial performance in Indian and Chinese securities markets across different industries. In the developed markets, such as the USA and Europe, similar results were found by Alareeni & Hamdan (2020) and Bartlett et al. (2020).

However, studies in South Africa by Johnson et al. (2019) and Chetty et al. (2014) found a negative relationship between ESG and firm performance, contradicting the findings of other countries. Researchers such as Johnson (2020), Sayed (2018), and Nkomani (2013) did not probe the effects of the individual ESG sub-pillars on the firm's financial performance. Furthermore, these studies did not investigate the impact of ESG on the key drivers of firm performance, such as asset utilisation, profitability, and leverage. This study addresses a gap in South African and foreign literature, focusing primarily on a single industry, the mining sector, with more detailed ESG and firm performance depth. This study thus aimed to determine the relationship between the ESG scores, and the financial performance of mining firms listed on the JSE, South Africa. Firms could also use these findings to prepare to mitigate the negative financial implications of specific ESG subcomponents before policies are introduced.

The mining sector relies heavily on its social pillar, particularly its labour force and environmental pillar, as raw materials are used throughout production (Stafford, 2021). Further, governance issues are a cause for concern in many South African mining firms, highlighting the need for research in this sector. The core operations of the mining sector correlate very well with the individual pillars and sub-components of ESG, thereby serving as a suitable industry for further exploration. Mills (2021) states that ESG issues across the different pillars offer the mining sector some of its biggest challenges regarding its daily operations and activities.

The remainder of the article is arranged as follows: The following section offers a critical overview of the literature on the relationship between ESG and firm performance, including theories underpinning the explanations for the different relationships. After that, the research methodology will be discussed, the collection of the quantitative ESG scores and the data analysis. The results, discussions, and conclusions, including study implications, limitations, recommendations for future studies, and concluding remarks, follow this.

2. Review of Literature

Literature on possible relationships between ESG and firm financial performance is explored in this section. The stakeholder theory put forward by Moskowitz (1972) is discussed, followed by Jones's (1995) agency cost theory; these theories explain the positive and negative relationships between ESG scores and firm financial performance. Global research on the overall ESG score in emerging and developing markets, including South Africa, is discussed, followed by an exploration of the literature on the relationships between the individual E, S, and G pillars and financial performance and the specific sub-components of these pillars.

2.1 Theoretical background

Two main theories explain the relationship between ESG and the financial performance of firms; the first is the stakeholder theory, and the second is the agency cost theory. The stakeholder theory states that every firm has different stakeholders that influence the actions of the firm and are influenced by the activities of the firm, for example, its customers, suppliers, and workers (Moskowitz, 1972). This theory supports the positive relationship between ESG and firm performance. The positive relationship revolves around how greater ESG compliance improves mutual trust and increases cooperation between the firm and the various stakeholders. The positive relationship reduces implicit and explicit costs experienced by the firm primarily attributed to these stakeholders, thus making the firm more profitable (Li et al., 2018).

Research conducted by Jones (1995) supported the stakeholder theory concluding that ESG better satisfies the interests of nonowner stakeholders, i.e., debtors, employers, customers, and regulators. Thus, the ESG factors allow for more efficient contracting and open new paths for further business growth, risk reduction, and long-term value creation.

The agency cost theory states managers will only partake in ESG compliance if it benefits their positions. Therefore, they will focus the firm's resources on ESG projects instead of other more relevant profit-producing projects (Naila, 2013), adding that this negatively affects the firm's price and profitability, as competitors who don't comply with ESG requirements will not incur the same costs and, in turn, may generate more returns for their shareholders. This theory supports the negative relationship between ESG and firm financial performance. Friedman (1970) best summarises this opposing relationship argument by claiming that maximisation of the firm's profits is the firm's only social responsibility. The agency cost theory, therefore, notes that these increased benefits from better

ESG compliance, such as positive social and environmental impacts, will not outweigh the increased costs to the firm and will therefore reduce its overall profitability and performance (Friedman, 1970).

Research conducted in developed markets and developing markets is presented below. European and North American countries were referenced to describe best-developed market findings, whilst BRICS member countries were assumed to describe emerging market findings best.

2.2 Developed market findings.

Alareeni & Hamdan (2020) analysed annual data for five hundred S&P 500 firms from 2009 to 2018, using the overall ESG scores presented on Bloomberg as the major indices in identifying environmental, corporate social responsibility (CSR), and corporate governance. The study evaluated the firm financial performance based on Return on Equity (ROE) and Return on Assets (ROA), using firm size, financial leverage, and asset growth as control variables. Their results showed that overall ESG scores tended to be higher for firms with greater financial leverage and a more extensive asset base. Firms with higher ESG scores showed better performance when utilising ROE and ROA.

Fatemi et al. (2018) research on 403 US-Listed, for the period 2006 to 2011, investigated the effects of ESG disclosure on ROE and firm value and found that increased ESG disclosure decreased firm value and ROE. The explanation was that the market might interpret increased disclosure as the firm's attempt to justify over-investment in ESG. The ESG disclosure may be perceived as a negative signal to the market, which drives down firm value through a reduced share price for listed firms.

Pasquini-Descomps (2013) study in the Swiss market for the period 2007 to 2011 utilised ESG news-based scores instead of the ESG compliance-based scores used by Fatemi et al. (2017) and, Alareeni & Hamdan (2020). The news-based scores were based on positive and negative news articles about a company found in newspapers and other media sources containing keywords concerning the environment, social, and governance. Pasquini-Descomps's study investigating how news-based scores in ESG would influence the yearly financial return found a significant negative relationship between improved labour ratings (included in the social component of ESG, which will impact the ESG score as a whole) and ROA. This would mean that a firm engaging in ESG activities could potentially increase its financial performance, supporting the stakeholder theory as previously discussed.

2.3 Developing market findings

In the emerging market group (BRICS), Dalal & Thaker (2019) conducted a panel study, analysing 65 listed Indian firms from 2015 to 2017, exploring the impact of ESG factors on the firm's profitability, performance, and value. The study found a positive relationship between good corporate ESG performance and financial performance assessed through market-based and accounting measures. Similarly, Zhao et al. (2018) examined China's listed power generation groups from 2007 to 2016 through a panel regression model. They found that better ESG compliance-based scores improved the financial performance of the power generation firms in China.

Studies conducted in South Africa by Demetriades & Auret (2014), Du Toit & Lekoloane (2018) used the JSE Socially Responsible Index (SRI) as a proxy for ESG. SRI constituents attained a higher ROE and ROA than conventional firms, concluding that social performance was positively - and sometimes significantly - correlated with ROE. Demetriades & Auret (2014) found a significant positive relationship between SRI and ROE when total assets were used as a proxy for size. Conversely, there was a significant negative relationship between ROA and the SRI when firm turnover was used as a proxy for size. Another study by Nkomani (2013) compared the financial performance of firms that were either members of the SRI or non-members of the SRI over the period 2002 to 2011 and found a significant negative relationship between members of the SRI Index and accounting-based ROA.

A South African study by Erasmus et al. (2017) investigated the relationship between a firm's CSR score and its financial performance using ROA, ROE, earning per share (EPS), and total shareholder return (TSR), using 230 firms from 6 different sectors, found a significant positive relationship between CSR and accounting-based EPS and ROA. There was also a significant negative relationship between CSR and market-based total shareholder return. In contrast, an earlier South African CSR study by Chetty at al. (2014) found that CSR activities do not significantly differ in financial performance.

Sayed (2018) compared the ROE and ROA of firms that had been ESG-compliant for more than five years between 2007 and 2017 with non-ESG-compliant firms. The study used a multiple linear regression model with ESG compliance as a dummy variable, market capitalisation as a proxy for size, and the debt-to-asset ratio used as a proxy for risk. The study found no significant relationship between ESG compliance and financial performance.

Most of the relevant South African research, such as that by Sayed (2018), Johnson (2020), and Nkomani (2013), broadly explored the relationship between ESG scores and financial performance. These papers investigated the relationship between industries and performance measurements in broad terms and did not probe the drivers of firm performance, such as profitability, asset efficiency, and leverage. Although researchers such as Du Toit & Lekoloane (2018) and Chetty et al. (2014) took individual industries into account in their analysis by using a control variable in the various statistical models, little industry-specific research and therefore, insight was provided.

Erasmus et al. (2019) studied six industries in South Africa using accounting, market, and value-based metrics. A panel regression analysis uncovered the individual E, S, and G scores' relationships with the firm financial performance metrics. The study concluded a significantly positive relationship between social scores and accounting-based EPS, market-based earning yield, and value-based return on invested capital, and a positive relationship

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between governance scores and ROA, return on invested capital (ROIC), and market value added (MVA) for the consumer goods sector. Firms in the consumer sector tended to benefit financially from high social scores.

In limited European studies, Bartlett et al. (2020) have explored the individual sub-components of the E, S, and G pillars using 1038 companies. These sub-components can clarify the relationship between ESG and firm financial performance. Scores for the environmental pillar included resource use, emissions, and environmental innovation; the social pillar included employee productivity, human rights, and worker diversity; and governance scores included quality of management and CSR strategy. ROA and ROE metrics were utilised to capture firm performance. The main findings revealed a positive relationship between environmental innovation, employee productivity, worker diversity and firm performance.

Detailed industry-specific analysis exploring the relationship between ESG scores, and financial performance has not been conducted on the mining sector in South Africa. This lack of research is surprising considering the size and importance of the industry to the South African economy. South Africa is estimated to have the world's 5th largest mining sector in terms of GDP (Langenhoven, 2020). In 2020, mining contributed to almost 8.7% of the country's total GDP and employed around half a million people in its workforce (Statistica, 2021).

The mining sector by itself is very relevant to particular ESG factors. Firstly, a high level of interaction occurs with environmental factors such as carbon emissions and water pollution. Secondly, social factors are relevant given the high level of employment in the mining process and the high probability of disrupting local communities through extensive land use. Thirdly, infringements of human rights arising from questionable employment conditions are an essential issue. Lastly, governance issues, particularly legal compliance, corruption, anti-bribery, and transparency, are relevant (Walker, 2021). companies have historically ranked very poorly on environmental, social, and governance indicators, which is why they may have been reluctant to disclose the information in the first place (Walker, 2021). The research illustrates poor compliance with the shift to a more environmentally and socially responsible world and the need for change in the sector. Propelled by investor demand and supported by a changing global economy, there is now widespread recognition in the mining industry globally that ESG has to be a core component of any mining company's strategy. South Africa will likely follow suit in this regard (Stafford, 2021), which is sufficient motivation for investigating these mining firms regarding their ESG and firm performance relationship.

The conflicting research incorporating an overall ESG score in both developed and developing markets is particularly interesting. Sayed (2018) had inconclusive findings, whilst Chetty et al. (2014) and Erasmus et al. (2019) found some positive relationships between ESG and firm performance and Biggs et al. (2017) found negative relationships. A variety of methods to test the relationship, particularly in measuring ESG as a score with several metrics deemed suitable, for example, ROE or ROA (2018) utilised a variety of compliance-based approaches, whilst Du Toit & Lekoloane (2018) used news-based strategies. The combination of methods illustrates the highly subjective nature of the most accurate way to capture ESG performance. However, using ROA and ROE for firm performance was a common choice amongst most global and domestic researchers (Demetriades & Auret, 2014; Erasmus et al.,2017). It also highlights that changing the metrics for firm performance could significantly alter the conclusions of the studies. Therefore, it is deemed appropriate to consider the key drivers of firm performance and show how ESG impacts these drivers.

The following research question is proposed from the gaps identified: Is there a significant relationship between environmental, social, and governance (ESG) scores and the financial performance of mining firms listed on the Johannesburg Stock Exchange (JSE)? The following hypotheses are formulated to answer the research question.

Hypothesis 1: There is a statistically significant relationship between the overall ESG score and the firm performance metrics of JSE-listed mining firms.

Hypothesis 2: There is a statistically significant relationship between either the E, S, or G pillar scores and firm performance metrics of JSE-listed mining firms.

Hypothesis 3: There is a statistically significant relationship between ESG sub-component scores and the firm performance of JSE-listed mining firms.

3. Methodology

The population for this study consisted of all JSE-listed mining firms from 2008 to 2020. The start of the research period coincides with the introduction of publicly available ESG scores of JSE-listed mining firms on the Refinitiv Eikon (2021) financial platform for South Africa. Convenience and judgment sampling were used to draw a sample from the publicly available database. The firm observations were selected based on the judgment criteria listed below.

- Data needed to be available from 9 years before 2021 for each mining company in South Africa.
- Complete information about all ESG disclosure scores and financial performance measurements had to be available on the Refinitiv Eikon (2021) database.
- The mining firm had to be listed on the JSE and have its headquarters in South Africa.

Based on the judging criteria above, only 13 out of the current 41 JSE-listed mining firms were headquartered within South Africa (other mining firms listed but headquartered elsewhere would have different activities, regulations, and practices that would compromise the validity of the investigation) and had the complete financial and

ESG data required for the study. Of the 13 firms in this study, 6 were gold mining firms, 1 was an iron ore miner, 4 were platinum miners, and 2 were multi-commodity mining firms.

The financial performance measurements used in the study were return on equity (ROE) and return on assets (ROA) used in previous studies by Alareeni & Hamdan (2020), Du Toit & Lekoloane (2018), and Pasquini-Descomps (2013), and asset turnover, financial leverage, operating profit, and net profit.

A panel regression analysis of 9 individual regression models investigated the relationship between the independent (various ESG scores) and dependent variables (financial performance variables). A two-way random-effects model was implemented to conduct our analysis. The chosen model increases the validity of the analysis since the Amemiya transformation reduces both the individual and two-way effects on the analysis, as used by Johnson (2020) and Erasmus et al. (2019).

The control variables for firm size and leverage were utilised in the analysis to improve the validity of the results. As firms become larger, they expect to receive more attention from various stakeholders and, in turn, be under tremendous pressure to comply with ESG requirements (Erasmus et al. (2019). In line with Du Toit & Lekoloane (2018), market capitalisation was used as a proxy for firm size, and the Debt to Assets ratio was used as a proxy for firm leverage. Ethical clearance was not required as all information was secondary data publicly available on the Thomson Reuters Refinitiv Eikon Platform.

4. Results and discussion

The following section tested the relationships between the ESG scores and financial performance metrics of South African mining sector firms. Firstly, an overall ESG score's relationship with financial performance was analysed, followed by an analysis of the individual E, S, and G pillar scores and their sub-components with financial performance. Panel regression analysis was conducted, implementing a two-way random-effects model with an Amemiya transformation to test the hypotheses at the 5% significance level.

The relationships between the overall ESG score and the financial performance measurements chosen for the study are shown in Table I below.

Table I: ESG scores and dependent variables

	Dependent variable:							
	Return On Assets	Return On Equity	Equity Turnover	Asset Turnover	Financial Leverage	Net Profit Margin	Operating Profit Margin	Interest Burden
Firm Size	**0.100*****	**-0.578*****	-0.015	**-0.344*****	**0.074*****	**0.101*****	-0.141	-0.015
	(0.015)	(0.104)	(0.024)	(0.077)	(0.018)	(0.024)	(0.105)	(0.047)
Leverage	-0.230*	**3.458*****	-0.127	**4.968*****	**-0.324****	-0.008	-0.285	-0.083
	(0.127)	(0.831)	(0.187)	(0.626)	(0.161)	(0.221)	(0.986)	(0.444)
ESG Score	0.001	-0.004	0.004	-0.009	0.002	0.005	0.017	-0.007
	(0.002)	(0.011)	(0.003)	(0.008)	(0.002)	(0.003)	(0.014)	(0.006)
Constant	**-2.059*****	**13.333*****	0.779	**8.978*****	**-1.644*****	**-2.352*****	2.868*	1.447*
	(0.323)	(2.282)	(0.542)	(1.690)	(0.377)	(0.505)	(1.708)	(0.762)
Observations	117	117	117	117	117	117	117	117
R^2	0.326	0.332	0.030	0.471	0.205	0.181	0.020	0.033
Adjusted R^2	0.308	0.314	0.004	0.457	0.184	0.160	-0.006	0.007
F Statistic	54.576***	56.215***	3.489	100.673***	29.180***	25.041***	2.349	3.867

Note: (Values in bold represent significant findings)
*p<0.1; **p<0.05; ***p<0.01

The results indicated no statistically significant relationships at the 5% level between the overall ESG score and the financial performance measurements. The findings may suggest that a mining firm's overall ESG score does not directly impact firm performance. These results align with Naila (2013) and Sayed (2018), who noted no significant relationship between the overall ESG score and ROE and ROA. However, studies by Alareeni & Hamdan (2020) had contrasting results; finding a significant negative relationship between the overall ESG scores and ROE.

However, according to Fernandez-Izuierdo et al. (2016), an overall ESG score could conceal different dimensions of ESG practices, reducing the accuracy of the overall score. In addition, Dahal & Thakar (2019) argue that the conflicting results of previous studies highlight the importance of investigating the individual 'Environmental',

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'Social', and 'Governance' pillars rather than only focusing on the overall ESG score. An additional panel regression analysis was conducted on the individual 'Environmental', 'Social' and 'Governance' pillars and the selected financial performance measurements. The results of the regression analysis are presented in Table II below.

Table II: Regression results for the ESG Scores on firm performance

	Dependent variable:								
	Return On Assets	Return On Equity	Equity Turnover	Asset Turnover	Financial Leverage	Net Profit Margin	Operating Profit Margin	Interest Burden	Tax Burden
Firm Size	**0.102*****	**0.163*****	**-0.575*****	-0.005	**-0.360*****	**0.080*****	**0.108*****	-0.152	-0.001
	(0.015)	(0.019)	(0.107)	(0.023)	(0.078)	(0.018)	(0.024)	(0.113)	(0.050)
Leverage	-0.183	**-0.362****	**3.699*****	0.111	**4.737*****	-0.246	0.116	-0.220	-0.0005
	(0.135)	(0.168)	(0.889)	(0.188)	(0.664)	(0.168)	(0.229)	(1.038)	(0.462)
E-Score	-0.001	-0.003	-0.007	-0.004*	0.006	-0.003	-0.004	0.011	-0.007
	(0.002)	(0.002)	(0.011)	(0.002)	(0.008)	(0.002)	(0.003)	(0.012)	(0.006)
S-Score	0.001	0.002	0.006	**0.008*****	-0.008	0.002	**0.004****	0.008	0.0004
	(0.001)	(0.002)	(0.009)	(0.002)	(0.007)	(0.002)	(0.002)	(0.012)	(0.005)
G-Score	0.00003	-0.00003	-0.006	-0.002	-0.004	0.002	0.002	-0.002	-0.002
	(0.001)	(0.001)	(0.006)	(0.001)	(0.005)	(0.001)	(0.002)	(0.009)	(0.004)
Constant	**-2.075*****	**-3.280*****	**13.340*****	0.641	**9.117*****	**-1.686*****	**-2.404*****	3.028	1.205
	(0.323)	(0.424)	(2.324)	(0.515)	(1.685)	(0.377)	(0.498)	(1.851)	(0.813)
Observations	117	117	117	117	117	117	117	117	117
R^2	0.333	0.443	0.340	0.157	0.478	0.227	0.209	0.025	0.040
Adjusted R^2	0.303	0.417	0.310	0.119	0.455	0.192	0.173	-0.019	-0.003
F Statistic	55.429***	88.109***	57.075***	20.628***	101.771***	32.544***	29.264***	2.872	4.637

Note: (Values in bold represent significant findings)
*p<0.1; **p<0.05; ***p<0.01

The analysis found no statistically significant relationship between the 'Environmental' pillar score and the financial performance measurements measured by ROA and ROE. The findings could suggest that a mining firm's 'Environmental' score does not have a conclusive impact on its financial performance. The findings differ from Bartlett et al. (2020), who found a statistically significant positive relationship between the 'Environmental' score and ROE and ROA.

The 'Social pillar' analysis showed no statistically significant relationship between the 'Social' pillar score and ROE and ROA, similar to Du Toit & Lekoloane (2018). This could suggest that a mining firm's 'Social' score does not have a conclusive impact on ROE or ROA. The findings contrast Demetriades & Auret (2014), and Nkomani (2013), who found a statistically significant negative relationship between the 'Social' score and ROE.

The 'Governance pillar' analysis showed a significant positive relationship between the governance score and asset turnover at the 1% level, suggesting that mining firms with higher Governance scores report a higher asset turnover over a given financial year. Furthermore, there was a significant positive relationship between Governance score and operating profit margin at the 5% level, suggesting that mining firms with higher Governance scores report higher operating profit margins over a given financial year. This result supports Bartlett et al. (2020) research, which noted a statistically significant positive relationship between the 'Governance' score and ROE and ROA and Erasmus et al. (2017) with ROA only.

The following section shows the results of a panel regression analysis between the ten sub-components of the overall ESG score and the chosen financial performance measurements of asset utilisation and profitability. The results of this analysis are presented in Table III below.

Table III: Regression Results for ESG sub-components on key financial performance measurements

	Dependent variable:								
	Asset Utilisation					*Profitability*			
	Return On Assets	Return On Equity	Equity Turnover	Asset Turnover	Financial Leverage	Net Profit Margin	Operating Profit Margin	Interest Burden	Tax Burden
Firm Size	**0.108*****	**0.164*****	**-0.658*****	-0.018	**-0.408*****	**0.089*****	**0.123*****	-0.100	0.020
	(0.014)	(0.019)	(0.099)	(0.022)	(0.076)	(0.018)	(0.024)	(0.136)	(0.059)
Leverage	**-0.339*****	**-0.507*****	**2.881*****	0.027	**4.096*****	-0.277	0.051	0.290	-0.105
	(0.128)	(0.175)	(0.861)	(0.194)	(0.672)	(0.177)	(0.241)	(1.385)	(0.618)
Resource Use	0.002	0.001	0.011	0.003	0.008	0.0002	0.001	0.002	-0.003
	(0.001)	(0.002)	(0.009)	(0.002)	(0.007)	(0.002)	(0.003)	(0.011)	(0.005)
Emissions	-0.001	-0.003	-0.010	**-0.007*****	0.004	0.001	0.0005	-0.008	-0.005
	(0.001)	(0.002)	(0.008)	(0.002)	(0.006)	(0.002)	(0.002)	(0.013)	(0.006)
Environmental Innovation	-0.001	-0.001	-0.006	-0.00003	-0.005	**-0.003****	**-0.005*****	-0.003	0.001
	(0.001)	(0.001)	(0.005)	(0.001)	(0.004)	(0.001)	(0.001)	(0.007)	(0.003)
Working Conditions	**-0.007*****	**-0.005****	**-0.030*****	**0.004****	-0.031*	**-0.006*****	**-0.007*****	0.020	-0.006
	(0.001)	(0.002)	(0.009)	(0.002)	(0.007)	(0.002)	(0.003)	(0.015)	(0.007)
Human Rights	**0.002*****	**0.002****	0.008	**0.003*****	0.001	**0.003*****	**0.005*****	0.003	-0.0001
	(0.001)	(0.001)	(0.005)	(0.001)	(0.004)	(0.001)	(0.001)	(0.007)	(0.003)
Community Impact	0.0002	0.001	-0.001	0.001	-0.001	-0.0002	-0.001	0.007	0.002
	(0.001)	(0.001)	(0.007)	(0.002)	(0.005)	(0.001)	(0.002)	(0.010)	(0.005)
Product Responsibility	-0.0001	-0.0003	0.003	0.0003	0.002	0.0003	-0.0001	-0.005	0.002
	(0.001)	(0.001)	(0.004)	(0.001)	(0.003)	(0.001)	(0.001)	(0.005)	(0.002)
Management Responsibility	-0.0001	-0.0003	-0.005	-0.001	-0.004	0.001	0.001	-0.0003	-0.001
	(0.001)	(0.001)	(0.004)	(0.001)	(0.003)	(0.001)	(0.001)	(0.007)	(0.003)
Shareholder Responsibility	-0.0005	-0.0004	**-0.007****	**-0.001****	**-0.005****	0.001	0.001	-0.001	0.002
	(0.0004)	(0.001)	(0.003)	(0.001)	(0.002)	(0.001)	(0.001)	(0.005)	(0.002)
CSR Strategy	**0.003****	0.002	**0.023*****	0.002	0.010*	0.002	0.001	-0.006	-0.004
	(0.001)	(0.001)	(0.007)	(0.002)	(0.006)	(0.001)	(0.002)	(0.011)	(0.005)
Constant	**-1.897*****	**-3.115*****	**15.815*****	0.691	**11.393*****	**-1.691*****	**-2.304*****	1.866	1.267
	(0.347)	(0.469)	(2.406)	(0.544)	(1.811)	(0.442)	(0.596)	(2.558)	(1.132)
Observations	117	117	117	117	117	117	117	117	117
R^2	0.541	0.532	0.523	0.277	0.594	0.397	0.382	0.044	0.061

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Adjusted R^2	0.488	0.478	0.468	0.194	0.547	0.327	0.311	-0.067	-0.047
F Statistic	122.675***	118.399***	113.957***	39.865***	152.014***	68.486***	64.376***	4.744	6.773

Note: (Values in bold represent significant findings)
*p<0.1; **p<0.05; ***p<0.01

4.1 ROA and ROE

The analysis found a strong negative relationship between working conditions and ROA (1% significance level) & ROE (5% significance level), suggesting that mining firms with better working conditions report a lower ROA over a given financial year. This finding supports Pasquini-Descomps (2013) findings, which noted a significant negative relationship between improved labour conditions and ROA. A possible explanation for this finding by Nelson & Pelders (2019) suggests that the additional costs South African mining firms incurred to improve working conditions do not lead to increased revenue and improved performance.

A strong positive relationship was found between human rights and ROA (1% significance level) & ROE (5% significance level). This finding could suggest that firms with a higher human rights score report a higher ROA supporting the research by Bartlett et al. (2020), who found a significant positive relationship between human rights considerations and ROA. According to MSCI (2021), there is evidence that a high level of human rights in the mining process is an essential consideration for customers when purchasing a mining-related product. Due to the extensive reporting of human rights abuses, firms with poor human rights records could develop a negative reputation, negatively impacting firm performance, as revenues are linked to changing consumer spending habits (Erasmus et al., 2019).

A strong positive relationship was found between CSR strategy and ROA at the 5% significance level, suggesting that firms with a better CSR strategy report a higher ROA. This positive relationship could result from the increased transparency associated with improved CSR strategy. Transparency improves mutual trust and increases cooperation between the firm and various stakeholders. Transparency could reduce implicit and explicit costs experienced by the firm primarily attributed to these stakeholders, thus making the firm more profitable (Li et al., 2018).

The measures of asset utilisation are asset turnover and financial leverage.

4.2 Asset turnover

A strong negative relationship was observed between emissions and asset turnover at the 1% significance level, suggesting that firms with a higher emissions score report a lower asset turnover. According to Richardson & Welker (2001), when firms invest in more environmentally friendly assets, they generate less revenue for firms than those invested in less environmentally friendly.

A strong positive relationship was observed between working conditions and asset turnover at the 5% significance level, suggesting that firms with higher working conditions scores report a higher asset turnover. An explanation for this relationship may be deduced from a finding by Refinitiv Eikon (2021), stating that the more emphasis a mining company places on health and safety systems, the lower the injuries per million hours experienced by workers. The lower injury count may increase the ability to generate more asset revenue (Asfaw et al.,2013).

In addition, a strong positive relationship was observed between human rights and asset turnover at the 1% significance level, suggesting firms that have a higher human rights score report a higher asset turnover over a given financial year. A strong negative relationship is found between shareholder responsibility and asset turnover at the 5% significance level. This finding suggests that firms with a higher shareholder responsibility score report a lower asset turnover over a given financial year, probably due to the higher cost of investing in assets.

4.3 Financial leverage ratio

A strong negative relationship was observed between shareholder responsibility and financial leverage at the 5% significance level, suggesting that firms with a higher shareholder responsibility score report lower financial leverage over a given financial year. Biggs, Botha & Scheepers (2017) noted that firms with a higher level of shareholder influence were less likely to take on leverage, as shareholders could potentially be more risk-averse than management.

Profitability was measured using net profit and operating margins.

4.4 Net profit margin and operating profit margin

A strong negative relationship was observed between environmental innovation and net profit margin at the 5% significance level and operating profit margin at the 1% significance level, suggesting that firms which have a higher environmental innovation score report a lower net profit margin and operating profit margin over a given financial year. Erasmus et al. (2019) offered a possible explanation for this result: namely that the costs required to implement initiatives that reduced the environmental impact of a firm's operations could have a negative effect on the earnings realised by the firm.

A strong negative relationship was observed between working conditions, net profit margin, and operating profit margin at the 1% significance level. This finding suggests that firms with a higher working conditions score report a lower net profit margin and operating profits.

A strong positive relationship between human rights and net profit margin and operating profit margin, both at the 1% significance level, suggesting that firms with a higher human rights score report a higher net profit and operating profit margin.

5. Research hypotheses conclusions

The first hypothesis states a statistically significant relationship exists between the overall ESG score and the firm performance metrics of JSE-listed mining firms. The analysis found no statistically significant relationships between the overall ESG score and financial performance measurements, thus rejecting the hypothesis.

The second hypothesis states a statistically significant relationship exists between the 'Environment', 'Social' or 'Governance' pillar scores and firm performance metrics of JSE-listed mining firms. The study found that although there was no statistically significant relationship between the 'Environmental' and 'Governance' pillars, the 'Social' pillar had a significant positive relationship with asset turnover and operating profit margin. Therefore, the study does not entirely reject the second hypothesis. It is concluded that a statistically significant relationship exists between the 'Social' pillar and the financial performance of mining firms listed on the JSE.

The third hypothesis states a statistically significant relationship exists between any ESG sub-components score and the firm performance of JSE-listed mining firms. The study showed significant negative relationships between financial performance and sub-components: emissions, environmental innovation; working conditions; and shareholder responsibility. The study also found significant positive relationships between financial performance and the following subcomponents: human rights and corporate social responsibility strategy. Therefore, the study does not reject the third hypothesis.It was concluded that there is a statistically significant relationship between an ESG sub-components score and the financial performance of mining firms listed on the JSE.

6. Implications and limitation

The findings of this study have implications for a variety of stakeholders. As previously noted, the trends in sustainable investment are placing a stronger emphasis on the ESG practices of mining firms, compounded by pressure from consumers, governments, local communities, and employees. In the future, mining firms could be left with no option but to improve their ESG practices. This study could be helpful for these firms as it could give them an understanding of the possible changes in the drivers of financial performance, both positive and negative when improving their ESG practices. Firms could prioritise improving ESG sub-components to enhance their financial performance in the short term. Firms could also use these findings to prepare to mitigate the negative financial implications of specific ESG subcomponents before policies are introduced.

Future research could be conducted using data from reliable alternative databases such as Bloomberg to test the reliability of the relationships, thereby reducing the possibility of incorrect ESG data due to reporting errors.

7. Conclusion

Environmental, social and governance-related challenges will continue to threaten the longevity of firms, especially those that are resource-intensive and employ a significant portion of a country's labour force, this being mining firms and the mining industry in particular. These challenges will only intensify as competition for resources grows, and the natural supply of these resources diminishes. Furthermore, as consumers shift their attention to more sustainable firms and policymakers focus on addressing these ESG challenges, mining firms must position themselves correctly to mitigate the potential downfalls these ESG challenges could create. Identifying the key drivers of mining firms' performance and breaking them down further illustrates the impact of the various individual ESG sub-components where more attention needs to be placed, and potential issues may arise.

The results reveal that when the overall ESG score is used, there was little to no statistical relationship between ESG and firm performance of the mining firms. When the individual Environmental, Social, and Governance pillar scores were analysed in isolation, only the social score illustrated a statistically significant relationship with firm performance and a positive relationship with asset turnover and operating profit margin. However, when the study delved deeper into the different sub-components of each E, S, and G pillar, it was noted that there were significant negative relationships between financial performance and the following sub-components: emissions; environmental innovation; working conditions; and shareholder responsibility and there were significant positive relationships between financial performance and the sub-components of human rights and CSR strategy.

Thus, corporate leaders and policymakers must acknowledge that ESG considerations combine diverse aspects, as shown by this study. To generate sustainable returns, mining firms must embrace the different subcomponents of ESG.

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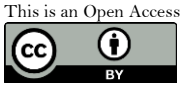

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The Renewable Energy Sources as a Lever of Sustainable Development

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ABSTRACT

Purpose:
The aim of this paper is to examine investors' economic and social profiles in renewable energy sources with the help of widely used investment rating indicators, such as Net Present Value, Internal Grade of Performance and Profitability Index.

Design/methodology/approach:
The study used an empirical research, gathering economic data from investments in renewable energy sources in the Regional Units of Thessaloniki, Imathia and Pella. Data was collected through a structured questionnaire, administered with personal interviews with investors, by applying a simple random sampling method through a population-total number of investors retrieved from the Ministry of Environment, Energy, and Climate Change records.

Findings:
The results demonstrate that investments in renewable energy projects are sustainable and highly efficient on a case-by-case basis. The main criterion for accepting an investment element in a specific renewable energy technology application is the calculation of the Internal Rate of Return. The optimal investment pertains to photovoltaic system installations. Among the investments, hydroelectric and wind investments are also enticing. Investments in wind energy have the highest net present value, followed by investments in photovoltaic and hydroelectric systems. Concerning the profitability index, it is observed that investments in photovoltaic systems have a higher profitability index, followed by investments in wind and hydroelectric systems. As far as social characteristics are concerned, the majority of investors, regardless of their profession, invest in photovoltaics. Freelancers predominantly invest in wind energy projects, while employees mainly invest in hydroelectric projects.

Research limitations/implications:
The main limitation of the survey is related to the sample, which consisted of investors from three regional areas of Greece. A future study may be conducted to a larger sample, from all Greek regional units and examine possible differences in the results related to geographical area and profile of the investors.

Originality/value:
From the literature review, it is found that there is a lack of a comprehensive scientific method for evaluating the optimal investment choice in the renewable energy sector, leaving potential investors without a reliable framework for assessment of investment proposals.
The current study can serve as a tool for investors in the renewable energy sector, assessing whether an investment yields financial gains compared to the capital allocated and therefore providing a tool to investors to know in advance the benefit of their potential investment.

1. Introduction

Renewable energy sources are derived from energy sources such as wind, solar power, hydropower, geothermal energy, biomass, and hydroelectric power (Andryeyeva et al., 2021). As we enter the 21st century, the world is facing an impending depletion of usable energy derived from fossil fuels, including oil, gas, coal, natural gas, and nuclear power. Unfortunately, renewable energies like wind and solar power have not yet reached a level of development that can fully replace traditional energy sources while providing flexibility. Consequently, humanity is now venturing

towards greater reliance on renewable energy due to the finite nature of fossil fuel resources. Multiple estimates indicate that proven oil reserves will likely be insufficient to meet global demand, at least by the middle of the 21st century (Ucal & Xydis, 2020).

Many developing and developed countries are rapidly increasing their installed capacity, and one factor contributing to this is their rising standard of living. The energy sector serves as a driving force for development and relies predominantly on the use of fossil fuels, whose availability is constantly decreasing. The need to transition away from conventional energy sources and the restrictive measures implemented by the European Union (EU) in its energy policy align with the promotion of Renewable Energy Sources (RES).

The transition towards an energy system based on renewable sources will enable the achievement of sustainable development (Bao & Fang, 2013) and the mitigation of global warming. In fact, numerous scientists and experts worldwide have affirmed the crucial and significant role that renewable energy can play in economic growth (Alper & Oguz, 2016), greenhouse gas emissions reduction (Kardooni et al. 2018), and job creation.

The European Union (EU) intends to become a global leader in renewable energy (RE) development under the Energy Union established (EC, 2015). As a result of Directive 2009/28/EC, the extended implementation of RE investments is a requirement for the EU Member States to meet the national binding targets by 2030 (EC, 2015). Moreover, the European Commission has also established ambitious energy and climate goals for 2030, including an increase of 27% in renewable energy consumption at the EU level by 2030 (EC, 2016; European Council, 2014).

Despite the persisting issue of low electrification rates in developing countries, substantial investments are necessary to enhance electricity supply and accessibility on a global scale (Nock et al., 2020). The International Energy Agency (IEA) estimates that non-OECD countries will need to invest USD 10 trillion in the electricity sector by 2035 (Manju & Sagar, 2017). Simultaneously, there are concerns that a greater proportion of energy consumption will continue to rely on fossil fuels, potentially exacerbating climate change. In this context, it becomes crucial for countries to establish stable social economies and sustainable growth. Governments and international agencies should provide various forms of support to the energy sector in industrialized nations, including financial assistance, technical guidance, and counseling (Lyulyov et al., 2021).

Greece has been actively promoting the development of renewable energy sources. The primary contributors to the country's gross energy production from renewables are wind power, photovoltaic solar panels, hydroelectric power, geothermal energy, and localized biomass, albeit at smaller capacities. Wind and photovoltaic energy installations are the most significant contributors (Eurostat, 2015). According to the latest National Energy and Climate Plan, Greece plans to generate 28 GW of renewable energy by 2030, up from 19 GW under the previous plan, aiming for an 80% share of renewable energy in its energy mix by the year 2030. In addition, the country is working on its National Hydrogen Strategy and preparing for the development of offshore wind farms, which have the attention of energy heavyweights around the world. The sunny, Mediterranean climate in Greece makes solar energy another key source of power. However, the increasing share of renewable energy from a limited number of technologies presents certain challenges (EU, 2016).

2. Literature review

The renewable energy sector in Greece is considered one of the most dynamic industries, and as such, numerous research efforts have been conducted by both Greek and foreign scholars. In their study, Masini & Menichetti (2013) state that investments in renewable energy sources (RES) are seen as an effective means of recovering from the economic crisis. However, there is limited penetration observed in this sector due to a lack of financing and reluctance to invest in these technologies. This particular study examines the factors that influence investors' decisions and the relationship between RES investments and portfolio performance. Through the application of econometric techniques on primary data collected from a sample of European investors, the study investigates how investors' beliefs, preferences, and attitudes are affected when it comes to investing in RES projects. Additionally, the study explores how portfolio performance increases with the rise in the share of RES in the portfolio.

El-Karmi & Abu-Shikhah (2013), in a relevant study, examined the impact of introducing economic incentives to promote renewable energy projects in Jordan. The incentives investigated include tax reduction, grace period introduction, capital provision or reduced prepayment interest, reduced asset depreciation, as well as the use of accelerated depreciation methods. The results obtained indicate that the implementation of such tools leads to improvements that encourage private individuals to invest in renewable energy sources. Furthermore, in the present study, the conducted conclusions showed that the fluctuations in both the grace period and the tax rate had minimal effects on the internal rate of return and net present value. On the other hand, increasing the depreciation period makes electricity generated from renewable sources more attractive compared to the straight-line depreciation method.

Ming et al. (2014), in their study, examined the investment prospects in renewable energy sources, financing sources, and funding channels. They also conducted a comparative analysis of wind and photovoltaic electricity.

According to Delapedra-Silva et al. (2022), the literature on the financial evaluation of renewable energy sources (RES) projects has extensively explored various methods, but there have been changes over time, driven by different factors. This article aims to analyze publications on the financial evaluation of RES projects from 2011 to 2020 and provide a critical analysis of the literature. The evaluation methods were categorized into four groups: (i) traditional metrics such as net present value, internal rate of return, and payback period; (ii) levelized cost of electricity; (iii)

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return on investment approach; and (iv) real options analysis. A quantitative analysis considered author relevance, productivity by country and the most influential journals for each group. Additionally, a qualitative analysis of the five most cited articles in each group was conducted. The findings reveal that traditional methods continue to be widely used for financial evaluation in RES projects. However, approaches based on levelized cost and real options have gained importance in addressing the complexities of financial evaluation and comparison of RES projects.

According to Steffen (2020), in energy economics, numerous models are used to assess the costs of alternative power generation technologies. These models rely on well-calibrated assumptions, particularly regarding the cost of capital or discount rates, which are crucial for renewable energy due to the wide variation in capital costs across countries and technologies. This article provides a comprehensive review of estimation methods for the private cost of capital in renewable energy projects and discusses their appropriate use to ensure unbiased results. Furthermore, empirical evidence from 46 countries during the period 2009-2017 is evaluated. The findings reveal a consistent global ranking order among technologies, with the cost of capital being highest for offshore wind power, followed by onshore wind and solar PV. On average, developing countries have significantly higher costs of capital compared to industrialized countries, and there is also substantial heterogeneity within each group.

Anton et al. (2020) analyzed the impact of financial development on the utilization of renewable energy within a panel dataset of 28 European Union (EU) countries from 1990 to 2015. The study employed a panel fixed effects model, incorporating income, energy prices, financial development, and foreign direct investments as variables. The empirical analysis revealed that all three aspects of financial development (banking sector, bond market, and capital market) had a positive influence on the proportion of renewable energy consumption. Furthermore, the results indicated that the development of the capital market did not significantly affect renewable energy consumption in the new EU Member States. These findings offer valuable insights into the effective allocation of capital within the renewable energy sector, aiming to provide competitively priced options to customers and ultimately foster the expansion of higher value-added services.

Angelopoulos et al., (2017) in their paper provided a comprehensive assessment of the existing risks associated with RE investments in Greece concerning the respective policies and evaluated their impact on WACC. In order to verify the findings, important individuals involved in the Greek renewable energy market were also consulted. These individuals include policy makers, project developers, investors, equity providers, bankers, and energy analysts. The conclusion drawn from these consultations is that the risk associated with policy design has the most significant impact on the cost of capital and, consequently, the level of investment in renewable energy projects. Through the cost of capital valuation process, it was determined that the weighted average cost of capital (WACC) for onshore wind projects in Greece is estimated to be around 12%, while solar PV projects have slightly lower values.

To date, various studies have approached this problem by evaluating the dynamics of Renewable Energy Projects (REPs) by category and comparing them both quantitatively and qualitatively. This differs from the international reality where sufficient effort has not been made towards assessing the fundamental financial mechanisms. Consequently, there is a lack of a comprehensive scientific method for evaluating the optimal investment choice, leaving potential investors without a reliable framework for assessment. This study aims to fill the specific gap. The objective of this study is to serve as a tool for investors, assessing whether an investment yields financial gains for the entrepreneurial investor in relation to the capital allocated. The specific goals are to investigate the economic profile of the sample under examination, followed by the development of mechanisms for evaluating investment proposals, and finally, the presentation of financing methods for Renewable Energy Projects (REPs).

2. Methodology

For this research, economic data from investments in renewable energy sources in the Regional Units of Thessaloniki, Imathia, and Pella were utilized. In Central Macedonia, there is the highest installed capacity of RES units (Kablioni, 2020). The techno-economic data used in the study were collected through a well-structured questionnaire administered during personal interviews with investors, conducted during the period of 2022. The data regarding the number of investors initially originated from the Ministry of Environment, Energy, and Climate Change (YPEKA) records. The completion time for each questionnaire was estimated at 60 minutes per investor. The sampling method employed for sample selection was simple random sampling (Siardos, 2005). Ultimately, a total of 139 investments were included in the sample. The questionnaire consists of two parts. The first part serves as an introduction and initial approach to the investor's profile, containing general questions regarding individual characteristics such as age, education, profession, and household income. The second part involves recording the techno-economic data of the investment. It includes questions related to the financial data of the investment. Additionally, there are questions concerning financial incentives, whether they come from grants or bank loans.

In order to evaluate a project, it is essential to conduct its financial assessment, enabling the investor to make a critical decision on whether to invest in it or not. The financial assessment constitutes the first step in project evaluation, and if the project is deemed financially unviable based on the assessment results, it is rejected. The annual cash flows were calculated. To evaluate an investment project financially, the annual cash flows were computed. The net cash flows are the sum of cash flows from capital investments and disposals, cash flows from changes in working capital, and operational cash flows. To determine whether an investment is profitable or not, certain investment evaluation indicators were examined, namely: Net Present Value (NPV), Internal Rate of Return (IRR), and Profitability Index (PI). The techno-economic analysis is the result of processing data from 30 fixed photovoltaic

projects, 65 mobile photovoltaic projects, 12 small-scale wind projects, and 32 hydroelectric projects. The results represent the average values within each project category.

3. Results

From the following table (Table 1), it is evident that for fixed photovoltaic installations, funding mainly comes from own capital (59,3%). Government subsidies account for 10% of the funding, while bank loans constitute approximately 31% of the total investment. In the case of mobile photovoltaic installations, funding primarily comes from own capital (53,4%). Government subsidies represent around 11% of the funding, while bank loans amount to approximately 36% of the total investment. For wind power projects, funding mainly comes from own capital at approximately 61%. Government subsidies make up 14,5% of the funding, while bank loans constitute 24,5%. Lastly, for hydropower projects funding is sourced from own capital at around 53%. Government subsidies account for approximately 10% of the funding, while bank loans amount to 36%.

Table 1: The financial structure of investments.

	Equity (%)	Government Grant (%)	Bank Loan (%)
Fixed Photovoltaic investments	59,3	10,0	30,6
Mobile Photovoltaic investments	53,4	10,7	35,7
Wind investments	60,8	14,5	24,5
Hydroelectric investments	53,4	10,1	36,4

Source: Author's construct, 2023

From Table 2 it is evident that mobile photovoltaics have a higher internal rate of return (38%) compared to other investments. They are followed by investments in fixed photovoltaics (30%), hydroelectric (26%), and wind energy (20%). The net present value is positive in all cases, with the highest value observed in wind energy. The profitability index is higher for fixed (15%) and mobile photovoltaics (14,5%), followed by wind energy (6%) and hydroelectric (5%).

Table 2: Calculation of financial indexes for renewable energy projects.

	Fixed Photovoltaic investments	Mobile Photovoltaic investments	Wind investments	Hydroelectric investments
Net Present Value (NPV) (€)	37.092,08	118.937,53	273.821,62	20.382,83
Internal Rate of Return (IRR)	30%	38%	20%	26%
Profitability Index (PI)	15%	14,5%	6%	5%

Source: Author's construct, 2023

From Table 3 it is evident that the majority of investors, regardless of their profession, invest in photovoltaics. Freelancers predominantly invest in wind energy projects, while employees mainly invest in hydroelectric projects.

Table 3: The profession of investors in renewable energy sources

	Employee (%)	Freelancer (%)	Farmer (%)	Retiree (%)	Household (%)	Student (%)
Fixed Photovoltaic investments	40	35	37	55	70	85
Mobile Photovoltaic investments	35	30	41	40	30	15
Wind investments	5	18	4	0	0	0
Hydroelectric investments	20	17	18	5	0	0

Source: Author's construct, 2023

From Table 4 it is evident that most investors in photovoltaic projects have an average income ranging from 1.001€ to 4.000€. In wind and hydroelectric projects, the majority of investors have a monthly income greater than 4.000€.

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Table 4: The average income of investors in renewable energy sources.

	0-1000 (%)	1001-2000 (%)	2001-3000 (%)	3001-4000(%)	>4000 (%)
Fixed Photovoltaic investments	32	65	45	20	5
Mobile Photovoltaic investments	60	25	32	35	10
Wind investments	5	0	15	20	45
Hydroelectric investments	3	10	8	25	40

Source: Author's construct, 2023

4. Discussion and Conclusions

In this paper, an evaluation of selected renewable energy investment projects was conducted. These specific investment projects were chosen to represent the entire spectrum of renewable energy technologies that an investor can choose from, covering both high and low investment capital. As the primary evaluation criterion for these investment projects, the internal rate of return (IRR), net present value (NPV) and profitability index (PI) were calculated.

The results demonstrate that investments in renewable energy projects are sustainable and highly efficient on a case-by-case basis. The main criterion for accepting an investment element in a specific renewable energy technology application is the calculation of the Internal Rate of Return (IRR). An investment plan is deemed acceptable when it presents a higher internal rate of return than the minimum required return defined by the investor. The optimal investment pertains to photovoltaic system installations. The expected reduction in equipment and installation costs is anticipated to make these investments even more attractive. Among the investments, hydroelectric and wind investments are also enticing. Furthermore, a criterion for evaluating and making investment decisions is the company's goal to maximize its net worth. This means that an investment proposal is favourable for the company when its contribution to the net value of the company exceeds the implementation cost. Investment decisions are made after a detailed and comprehensive evaluation of the relevant proposals, and their significance for the well-being and further development of the company is significant due to the magnitude of the required capital and the long-term implications that these decisions entail for the entire enterprise. According to the results presented in the previous section, at Table 2, investments in wind energy have the highest net present value, followed by investments in photovoltaic and hydroelectric systems. Finally, concerning the profitability index, it is observed that investments in photovoltaic systems have a higher profitability index, followed by investments in wind and hydroelectric systems. As it concerns social characteristics, in terms of their professional status, employees were predominant, followed by self-employed professionals. The average household income was in the range of 2501-3000 euros, which, for more than half of the respondents, came from their work.

Generally speaking, there are possibilities for improving the economic efficiency of investments in renewable energy projects to ensure their sustainability. Established support mechanisms for renewable energy sources (RES) are crucial for this purpose. Future frameworks for the remuneration of generated energy from RES should be designed with the primary objective of ensuring the economic viability of investments and further penetration of RES in a secure and stable environment. Numerous plans are being examined by the global scientific community and it is particularly interesting to explore the framework under which the RES energy market will operate in the future. Better economic results can be achieved through advancements in material technology, characterized by higher efficiency, and maximum utilization of natural resources, leading to a reduction in initial investment costs and operational expenses. These factors will contribute to reducing the economic risk associated with such investments.

The main limitation of the survey is related to the sample, which consisted of investors from three regional areas of Greece. A future study may be conducted on a larger sample, from all Greek regional units and examine possible differences in the results related to geographical area and profile of the investors.

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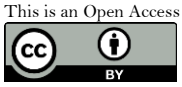

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Investors' Decision-making Under Risk: Evidence from the Croatian Stock Market

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ABSTRACT

Purpose:
This article deals with the retail investors' decision-making under risk, firstly addressing several theories of decision-making under risk. Following this theoretical framework, an analysis on investment strategies on the Croatian capital market has been conducted.

Design/methodology/approach:
In this paper a non-parametric Data Envelopment Analysis (DEA) methodology is used to estimate input-oriented efficiency (minimization of risk i.e. stock return volatility, standard deviation) in retrospect to monthly stock returns of 15 selected stocks (due to a liquidity criteria) and five stock indices on the Croatian stock market in the period from 2016 until 2021.

Findings:
Results show that just but a few stocks provide high efficiency levels on the Croatian stock exchange, while the general CROBEX stock index proves to be a viable investment option for retail investors whose financial knowledge, expertise and time are limited.

Research limitations/implications:
This study was conducted on a limited sample of 15 most liquid stocks and five stock indices on the Croatian stock market in the period from 2016 until 2021. Due to the limited number of liquid stocks through time, the shallowness and illiquidity of the Croatian stock market provides a major limitation of this study. Furthermore, the limited sample attained dictated the use of nonparametric static DEA methodology that is suboptimal. For future studies, it is recommended to internationally expand the sample and use dynamic nonparametric and parametric techniques in stock efficiency estimation.

Originality/value:
The main aim of the study was to provide a theoretical overview on the theories of decision-making under risk. These theories provide insight that investors (retail but institutional nonetheless) are more loss avoidant than return seeking (risk aversion) which in the end affects their optimal investment strategy. In addition, this study used DEA methodology in efficiency estimation of 15 stocks on the Zagreb Stock Exchange (ZSE). The results from this study suggest that for untrained and inexperienced retail investor the investment in the general stock index could be a viable investment strategy. This study builds upon several studies on investment strategies on the Croatian stock market by providing more insight on stock and stock indices returns and efficiency several years previously and during the COVID-19 pandemic. Future studies dealing with similar topics should expand to a multinational sample that would solve the two main limitations of this study. Therefore, by expanding the sample to neighbouring countries, and increasing the number of liquid stocks observed and the possibility of using dynamic nonparametric and stochastic models in efficiency estimation of stocks to determine adequate investment strategies.

1. Introduction

The field of study that focuses on decision-making under risk has been in development now for seventy years. However, the notion of uncertainty and risk is old as humanity itself since there was, and always will be variability of outcomes to our decisions. Whether we are aware of the probabilities of those outcomes (risk), or the probability distribution is unknown (uncertainty) there are no riskless decisions. Certainly, there is variability in the size and occurrence of risk tied to a decision. Closest to true riskless decisions are decisions with risk low enough in combination with enormous benefits (outcomes) that in retrospect to their risk can be deemed negligible and subsequently could be discarded from the decision-making process. A true riskless decision is only achieved in a hypothetical situation where there is only one outcome that has no variability and therefore its certainty of occurrence is unquestionable (probability of occurrence of the outcome is 1 or 100%). A basic definition of risk would be the variance of the probability distribution of possible gains and losses attributed to a specific decision.

This paper deals with relevant theories of decision-making under risk, taking a special interest on brokers, retail, and institutional investors' behaviour on the of Croatian stock exchange. The main goal of this study is to present current decision-making theories under risk. Furthermore, this paper aims to provide empirical evidence on investment strategies of retail investors and asses their validity on the Croatian stock market firstly defining efficient stocks on the ZSE (Zagreb Stock Exchange, i.e. the equivalent of the Croatian stock market). The estimation of efficient stocks is achieved using DEA methodology using constant and variable returns to scale. In the following section, a brief theoretical background on decision-making under risk from economics, psychology, and biology is presented. The same section also provides a brief literature review on current studies on investment strategies, efficient portfolios and stock estimation, and investors' behaviour on the stock market. The methodology used in this paper is presented in the third section, with a brief statistical overview of the data. In the subsequent section, results of the optimization model are discussed. The final, fifth section highlights the main conclusions of this empirical study and provides recommendations for future research.

2. Review of Literature

2.1 Theoretical Review

In economics, the Theory of Utility of Wealth remains a dominating theoretical framework for decision-making under risk. This theory describes a s-function of utility of wealth, concave in the first part, and it is convex in the second part, explaining the risk averse and risk seeking behaviour od decision maker first conceptualized by Friedman & Savage (1948). The theory was further expanded by (Markowitz, 1952b). Describing a rational individual means that more wealth is always preferred, (more wealth is always better), however subject to a diminishing marginal utility with any additional monetary unit. Therefore, Friedman & Savage (1948) and Markowitz (1952b) describe investors' behaviour decision-making under risk using the expected utility theory framework, describing individuals risk averse (concave), risk seeking (convex) and risk neutral regarding their willingness to tolerate potential losses.

Nonetheless, in the past seventy years there have been many breakthroughs in studies conducted on understanding of decision-making under risk. Today, decision-making is an interdisciplinary topic, it is extensively researched in the fields of psychology, economics, but also in biology. An integrated view to the most influential theories of decision-making such as expected utility theory, prospect theory, heuristic approaches and risk-sensitivity theory is provided by Mishra (2014). Integrating these widely broad and inconsistent perspectives to develop a synthesis of all these theories, creating a general theory of decision-making under risk is challenging.

However, greater understanding of human behaviour under risk and its decision-making process would provide significant improvement in predicating human behaviour in general. The benefits of this integration are not just present in advancing the fields of psychology and biology, but in economics in terms of investors and decision-makers (consumers) behaviour. Better understanding of investors' actions on the financial markets could be proven useful in developing more efficient investment strategies, and in the long run affect improve the stability of the financial system. This process of integration has already started with combining elements from psychology and economics, creating a new field of behavioural economics, or behavioural finance that attempts to relax the limitations of the rationality postulate of neoclassical economics.

The core of Expected Utility Theory was already briefly addressed in the previous paragraph, it is necessary to briefly elaborate on other decision-making under risk theories. Firstly, the prospect theory developed by Kahneman & Tversky (1979). Prospect theory started as a critique to the expected utility theory descriptive power of decision-making under risk. A good overview of prospect theory is provided by Barberis (2013) who addresses its use in finance explaining the disposition effect and the momentum effect. Empirical research on the disposition effect, and other individual investors fallacies are provided by (Barber et al., 2009; Barber & Odean, 2000; Odean, 1998).

Further development in explaining behaviour and decision-making under risk are heuristic approaches ("rules of thumb" an efficiency algorithm in decision-making) provided by the work of Slovic and his colleagues (for an outline of heuristic approaches see (Finucane et al., 2000; Slovic, 1972, 1993; Slovic et al., 1972, 1985, 2004, 2007). One important socioeconomic trait of investors is trust, in its counterparties, the market, and economic theory. Chiles & McMackin (1996) state that within the paradigm of transaction cost economics managers have variable risk preferences, as well as the importance of trust in transactions. Trust is an economizing agent, reducing transaction

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costs, eliminating and reducing unnecessary bureaucracy and making business transactions more efficient. Authors' define trust as the person's increase in vulnerability to the risk of opportunistic behaviour to the person's transaction partner, while the other person's (transaction partner) behaviour is not under its control. Furthermore, the situation dictates that the costs of violating trust are (much) greater than the benefits of upholding the trust. The final decision-making theory comes from the field of biology. Risk-sensitivity theory as described by Mishra (2014) is a normative theory that explains decision-making on the premise (assumption) that organisms ultimately behave to enhance their reproductive success or fitness see (Hintze et al., 2015; Kacelnik & Bateson, 1997; Satchell et al., 2018; Weber et al., 2004).

Risk-sensitivity theory explains that for decision-makers is not necessary to maximize desirable outcomes (energy budget requirements, in modern terms level of income) but rather the goal is to optimize the fulfilment of one's needs. In other words, the decision-making strategy is to avoid outcomes that fail to meet these needs, and to focus on outcomes that are "good enough" to meet the basic needs at any given time (Maslow's pyramid (hierarchy) of needs).

In this chapter prominent theories of decision-making under risk where presented. The following chapter deals with a brief literature review of current empirical studies on investors' decision-making behaviour.

2.2 Previous studies

Investment decisions are a trade-off between immediate consumption and deferred consumption. In other words, investments are decisions on current gratification (utility maximization) and delayed gratification with risk (decreased utility in the present with the goal of higher satisfaction in the future). This definition is in close relation to the famous Marshmallow test, however in the test there is no variation in the outcomes, as they are guaranteed. Therefore, there is no risk in such situations, a clear departure from the real world of stock investments. On the other hand, investments are subject to volatility i.e. variation of outcomes that can differ in retrospect to the expected outcome that is the basic definition of risk in modern finance. Even though economic theory at its core relies on the rationality postulate, decisions made by individual investors are still subjected to emotion, biases, intuition, and limitations of their statistical knowledge.

Furthermore, institutional investors are just complex organizations consisting of professional investors that in the end are still human. Consequently, they subject to the same behavioural challenges, fallacies (although not to the same extent) as individual investors (Slovic, 1972, p. 780) states that most of the time people bypass formal statistical procedures when making judgements, becoming "intuitive statisticians". Investors (individual and professional) and brokers' intuition still presents the majority of their decision-making process. Subjective predictions are based on the state of mind, feelings and attitudes, not necessarily knowledge, and they are not entirely the product of well-defined reasoning. Investors' decision-making is not as rational as thought to be, and very few investors, or investment firms are able to beat the market in the long run. Furthermore, there seems to be empirical evidence (see Slovic, 1972, p. 787) that longer work experience of a broker in the valuation and investment business made his insight into his weighting policy (decision-making process) less accurate – less clear. Even with formal training in statistic, people more than often rely on their intuition to make the final decision. Slovic (1972, p. 796) argues that decision made in groups are on average riskier than decisions made by individual investors, and it seems that individual risk-taking levels increased following group discussion. This behaviour could be explained by herd behaviour where each individual investor feels less personal blame in the case of losses. In other words, following the group, individual investor's responsibility is diffused to the group, making the investor less afraid, and more prone to riskier investments – exhibiting risk-seeking behaviour. Slovic et al. (1972) suggested that the use of mathematical models such as the analysis of variance (ANOVA) or multiple regression (even if not entirely optimal) could be useful in improving investors' decision-making. Authors argue that since human (investor's) decision-making tends to become erratic, affecting their accuracy due to errors in judgment, the use of mathematical models will reduce these errors, improving investor's judgment and enhancing their success on the stock market. Therefore, it is possible to deduce that individual investors are prone to irrational investment decisions, see (Gill et al., 2018; Hilton, 2001; Kafayat, 2014; Odean, 1998b; Sarwar & Afaf, 2016; Syed & Bansal, 2018).

On the other hand, Forlani & Mullins (2000) study the perceived risks and choices in entrepreneurs' new venture decisions. By the nature of their work, entrepreneurs do not see themselves as risk takers, but as opportunity takers that others do not see. In authors' opinion, there is a distinction between entrepreneurs' perceptions of risk and decisions involving risk arguing that they are separate cognitive processes. The conclusions raised are that entrepreneurs are more prone to choose ventures with higher hazard (grater loss and gains) with low probability. Finally, there is evidence that entrepreneurs exhibit risk propensity while choosing new ventures, while risk perception remains present and unchanged. Behavioural finance as a new field has a difficult task of identifying and defining the idiosyncrasies of investors' decision-making. Decision-maker's preferences are complex, open to change, and often formed or influenced during the decision process itself. Langevoort (1996) presents the dynamic relationship between stockbrokers and their sophisticated customers – investors. Stockbrokers offer their professional expertise to buy and sell financial products on behalf of their clients to maximize their returns – profits since most of the time their compensation for brokerage services is based on the volume and intensity of the trading orders.

Additionally, the sophisticated costumer (investor) uses brokers' services to save on time, transaction costs, and to gain, collect additional information, as well as, psychologically transferring some responsibility of investments made. Therefore, brokers are often tempted to mischaracterize an investment's level of risk, while investors may behave

excessively risk seeking when offered an investment opportunity by the broker. The relationship between brokers and investors is fruitful when the investments generate at least positive or expected returns. Great losses will incentivize investors to blame brokers for the misfortune, since they have made the investment based on their advice. As in all human relationships, trust takes a central place between the brokers and investors professional relationship. According to the author, brokers tend to be motivated not only by their training, but also by their goal of maximizing commission income to gain, build and cultivate investors trust. Investors on the other hand, are influenced to inherently trust the broker, and their trust level will rise if brokers' advice and recommendations prove to be true and profitable (importance of trust on professional relationships have been studied by Chiles & McMackin, 1996; Slovic, 1993).

However, when investments generate large losses, investors will blame their brokers for inaccurately disclosing information on the risk of investment or for giving bad advice. Brokers will defend themselves by indicating that the losses are a product of investor's greed that incentivized them to invest in investments with greater risk that promised greater returns, and now are not able to take on the responsibility for the occurred losses. Finally, it is necessary to impose caution when investing and following investment advice from brokers, moderation and restraint are advised to investors, since brokers deal with the sale of hope but also risk that is out of anybody's control.

There are several empirical studies conducted on the Croatian stock market i.e. Zagreb stock exchange (ZSE) that address investment strategies of Croatian investors. A study from Altaras Penda (2017) shows that there is no correlation between publicly listed Croatian companies' financial performance (income) and stock price, contradicting decades of economic and financial theory, indicating investors' irrational behaviour on the ZSE. The only certainty is market volatility (change of prices), market socks, risk and uncertainty. (Erjavec & Cota, 2007) investigate the influence of international financial markets on the short-term volatility of ZSE. Empirical results show that American stock exchange indices movements influence – affect the direction of change of the CROBEX index. The effect of changes in stock market index composition on stock returns on the ZSE is empirically tested by Škrinjarić (2019). Main findings show that investors in short term devalue stocks (producing negative returns) upon their exclusion from the market index (CROBEX). Furthermore, an investigation on investment strategy on the ZSE by implementing a dynamic DEA methodology is provided by Škrinjarić (2014). Results suggest that using DEA methodology can be useful in detecting – identifying efficient stocks (optimal stocks providing the best return-risk ratio i.e. the maximum return and the lowest risk). Furthermore, the dynamics between risk and performance of ZSE stock indices is studied by (Škrinjarić , 2015). Empirical results suggest that using MGARCH dynamic models can be a useful investing strategy on the ZSE. Portfolios based on the implemented methodology outperformed the market, as well as, average portfolios, in terms of return and risk. The Croatian stock market is problematic because of its shallowness and low liquidity. Investors have just but a couple dozen stocks to choose from that are considered liquid enough, traded regularly (monthly) to be deemed a viable investment. These limitations put to the test the traditional market theories from economics (for reference, and empirical evidence on the applicability of the SML model on the Croatian capital market see (Benazić & Uč kar, 2018; Uč kar & Nikolić , 2008).

3. Methodology and data

In this paper, following the methodology used by (Škrinjarić , 2014) in using the Data Envelopment Analysis (DEA) as a method of estimating efficient stocks and devising potential investment strategies that would predominantly outperform the market. However, in retrospect to Škrinjarić (2014) where monthly data of 26 stocks from ZSE in the period from April 2009 until June 2012. The period used in this paper is from January 2016 until December 2021 using weekly stock returns. Weekly stock returns are calculated using ZSE data at the end of the day (closing price) for every Friday in the observed period. In the case that there were no transactions of a stock on a Friday, the closing price of the previous trading day was subsequently taken into account.

The use of weekly data is actually one of the recommendations of the before mentioned paper, since it could reflect intra-month oscillation. Selected stock indices (due to liquidity constraints and continuity of the stock index) were examined, one general (CROBEX), and four sectoral: CROBEXindu (industry), CROBEXkons (construction), CROBEXnutr (nutrition), CROBEXturi (tourism). Furthermore, only 15 stocks listed on the ZSE were selected for the same liquidity reasons in the period from January 2016 until December 2021. Most of these stocks are also part of the examined sock indices. This limited sample of just 15 stocks gives insight into the characteristics of the Croatian capital market. The market is shallow and illiquid, in the sense that there are not many investment options available to institutional, but also retail investors (shallowness of the market). However, institutional investors have the ability to invest internationally, being able to access international capital markets and possessing the time and expertise in international investing. Liquidity concerns are also a limiting factor, given the small number of choices on the ZSE. Institutional as well as the retail investors must define their liquidity criteria, and subsequently even further limit their investment options on the Croatian capital markets. The observed stocks are AD Plastik (ADPL), Adris grupa. (ADRS), Arena Hospitality Group (ARNT), Atlantic grupa (ATGR), Atlanska plovidba (ATPL), Dalekovod (DLKV), Ericsson Nikola Tesla (ERNT), Hrvatski Telekom (HT), Konč ar (KOEI), Kraš (KRAS), Maistra (MAIS), Podravka (PODR), Valamar Riviera (RIVP), Brodogradilište Viktor Lenac (VLEN), and Zagrebač ka banka (ZABA). Monthly returns R_{ik} for i-th stock in the k-th, i $\in$ {1,2,…,20}, k $\in$ {1,2,…,72} month are attained as the average of weekly returns that are calculated using the following formula, without taking into account dividends:

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$$R_{ik} = \frac{\sum_{j=1}^{n_k} r_j^{ik}}{n_k} \quad (1)$$

$$r_j^{ik} = ln \frac{P_j^{ik}}{P_{j-1}^{ik}}, j \in \{1, \dots, n_k\} \quad (2)$$

Where r_j^{ik} is j-th weekly return on Friday j that is calculated as a natural logarithm of closing price P_j^{ik} on Friday j of i-th stock (index) in the k-th month divided by i-th stock (index) in the k-th month price from the week (on Friday j-1) before P_{j-1}^{ik}. Finally, n_k is the number of weeks in the k-th month. Monthly returns are plotted in the Graph 1 in the Appendix that provides some insights in the movement of returns in the observed period.

Firstly, investors (being institutional or retail) cannot make an investment decision based just on the return alone. In general, stocks (and indices) have similar returns throughout the observed period. Therefore, additional testing is needed based on variance of returns (standard deviation) or using fundamental analysis data (financial indicators) in estimating the best (most efficient) investment options in this sample. Averaged monthly stock (indices) returns in general move from 10% to -10% but averaging to 0,15% in the observed period. Only a few stocks generate higher average monthly returns, their maximal values are over the arbitrary 10% threshold, ADRS (20.63% in February 2020), ATPL (12.36% in October 2016), DLKV (89,89% in July 2021 as a consequence of merging 100 shares in one the same month), KRAS (24,9% in September 2019), VLEN (11,67% in March 2016). The Nutrition index (CROBEXnutr) achieves a maximum return of 10,86% (September 2019). However, returns are just one motive for investors' decision-making, as the common postulate in finance states, higher returns dictate higher risk levels and vice versa. Modern portfolio theory (MPT) is an optimization program in choosing stocks (portfolios) with an optimal ratio of risk and return based on the investor's risk preference (Markowitz, 1952a). The basis for risk in MPT is return dispersion around the mean (mean variance, or standard deviation). Therefore, when analyzing stock returns it is necessary to study standard deviation as a measure of volatility, or risk. For this reason, makes sense to implement a DEA methodology on stocks in estimating their "efficiency" since it is a linear programming model of optimization (seeking the best returns in respect to the lowest risk – standard deviation). Standard deviation is calculated as:

$$\sigma_{ik} = \sqrt{\frac{\sum_{j=1}^{n_k} (r_j^{ik} - R_{ik})^2}{n_k}} \quad (3)$$

Summary statistics of the calculated variables are presented in the following Table 1.

Table 1 Summary statistics of weekly returns for the observed stock indices and individual stocks in the period from January 2016 until December 2021

Stock (Index)	Minimum	Maximum	Average	Standard deviation
CROBEX	-6,14%	1,78%	0,08%	1,07%
CROBEXindu	-7,39%	4,59%	0,06%	1,60%
CROBEXKons	-10,35%	6,93%	0,03%	2,82%
CROBEXnutr	-7,31%	10,86%	0,03%	2,00%
CROBEXturi	-6,84%	3,24%	0,13%	1,28%
ADPL	-12,76%	5,13%	0,19%	1,99%
ADRS	-17,95%	20,63%	0,12%	3,47%
ARNT	-12,61%	4,30%	0,00%	2,01%
ATGR	-4,55%	3,08%	0,24%	1,16%
ATPL	-13,45%	12,36%	0,42%	3,97%
DLKV	-36,80%	89,89%	0,33%	11,93%
ERNT	-3,21%	3,32%	0,19%	1,13%
HT	-1,86%	2,34%	0,09%	0,84%
KOEI	-5,02%	4,61%	0,11%	1,39%
KRAS	-7,62%	24,97%	0,18%	3,39%
MAIS	-7,60%	4,00%	0,12%	1,42%
PODR	-4,58%	5,24%	0,23%	1,34%
RIVP	-9,86%	4,01%	0,10%	1,86%
VLEN	-6,63%	11,67%	0,20%	3,58%
ZABA	-5,03%	3,14%	0,18%	1,37%

Source: Author's construct based on Zagreb Stock Exchange trading data ZSE (www.zse .hr) in the period from January 2016 until December 2021.

As mentioned before, several studies recently implemented DEA methodology on the Croatian stock market see (Gardijan & Kojić , 2012; Gardijan & Škrinjarić , 2015; Škrinjarić , 2014, 2015). With the goal of estimating individual efficient stocks, DEA (Data Envelopment Analysis) methodology is used. DEA is a linear programming method that benchmarks the DMU's (decision-making units) regarding their distance to the efficiency frontier. However, stocks are more of assessment units than decision-making units (DMU). The methodology was first established by Charnes et al. (1978) for a model that assumes constant returns to scale (CRS) often called "CCR model". Further improvements were provided by Banker et al. (1984) by incorporating additional constraints allowing for variable returns to scale (VRS) often called BCC model. Both models can be input (minimization) or output (maximization) oriented. Following these seminal papers, the methodology was additionally developed in several directions (addressing the effect of environmental variables, undesirable outcomes, incorporating stochastic elements, dynamic models, network models, etc.). Only a brief overview of the general model is provided here.

The DEA model is calculated as the ratio of weighted outputs to weighted inputs for each DMU as shown in (4) to (7). It is necessary to obtain values for the input "weights" (v_i) where i = 1,…, m and the output "weights" (u_r) where r = 1,…, s.

$$\max_{u,v} \theta\,(u, v) = \frac{u_1 y_{1j} + u_2 y_{2j} + \cdots + u_s y_{sj}}{v_1 x_{1j} + v_2 x_{2j} + \cdots + v_m x_{mj}} = \frac{\sum_{r=1}^{s} u_{r0}}{\sum_{i=1}^{m} v_i x_{i0}} \quad (4)$$

subject to

$$\frac{u_1 y_{1j} + \cdots + u_s y_{sj}}{v_1 x_{1j} + \cdots + v_m x_{mj}} = \frac{\sum_{r=1}^{s} u_r y_{rj}}{\sum_{i=1}^{m} v_i x_{ij}} \leq 1, \text{ where } j = 1, \ldots, n \quad (5)$$

$$u_r \geq 0, r = 1, \ldots, s \quad (6)$$

$$v_i \geq 0, i = 1, \ldots, m \quad (7)$$

Since the fractional programming model from (4) to (7) has an infinite number of solutions (the optimal solutions u^*, v^* allow that every positive scalar c, (cu^*, cv^*) is also optimal). In order to simplify and solve the fractional programming model it is necessary to define the weighted sum of input variables equal to one (8). Using this transformation in it is possible to select a representative solution (u, v) constructing the linear programming model in (9) to (13) that is also known as the CCR model.

$$\sum_{i=1}^{m} v_i x_{i0} = 1 \quad (8)$$

$$\max_{u,v} z_0 = \mu_1 y_{1o} + \cdots + \mu_s y_{so} = \sum_{r=1}^{s} \mu_r y_{r0} \quad (9)$$

subject to

$$\sum_{r=1}^{s} \mu_r y_{rj} - \sum_{i=1}^{m} v_i x_{ij} \leq 0, j = 1, \ldots, n \quad (10)$$

$$\sum_{i=1}^{m} v_i x_{i0} = 1 \quad (11)$$

$$\mu_r \geq 0, r = 1, \ldots, s \quad (12)$$

$$v_i \geq 0, i = 1, \ldots, m \quad (13)$$

The dual of the CCR that assumes CRS (9) to (13) for each DMU can be written as:

$$\min_{\lambda} z_0 = \Theta_0 \quad (14)$$

subject to

$$\sum_{j=1}^{n} \lambda_j y_{rj} \geq y_{r0}, r = 1, \ldots, s \quad (15)$$

$$\Theta_0 x_{i0} - \sum_{j=1}^{n} \lambda_j x_{ij} \geq 0, i = 1, \ldots, m \quad (16)$$

$$\lambda_j \geq 0, j = 1, \ldots, n \quad (17)$$

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Where θ_0 is a scalar and its value denotes the efficiency score for the i-th DMU in our case stock, and λ_j is a Nx1vector of constants. Adding a convexity condition for λ_j (by setting the sum of components of the vector λ_j to one) the model now allows variable returns to scale (VRS) and it's the input-oriented BCC model (18) to (22):

$$\min_{\lambda} z_0 = \Theta_0 \quad (18)$$

subject to

$$\sum_{j=1}^{n} \lambda_j y_{rj} \geq y_{r0}, r = 1, \dots, s \quad (19)$$

$$\Theta_0 x_{i0} - \sum_{j=1}^{n} \lambda_j x_{ij} \geq 0, i = 1, \dots, m \quad (20)$$

$$\sum_{j=1}^{n} \lambda_j = 1 \quad (21)$$

$$\lambda_j \geq 0, \mathrm{j} = 1, \dots, \mathrm{n} \quad (22)$$

Monthly average returns R_{ik} represents the output variable for every i-th stock in every k-th month, and standard deviation σ_{ik} represents the input variable for every i-th stock in every k-th month. Following the procedure proposed in da Costa Jr et al. (2008) of standardization, re-scaling, and normalization was implemented since standard DEA models do not accept negative values. Since DEA is a non-stochastic technique, it does not implement a random error term in efficiency estimation, and it is vulnerable to noise and computational mistakes, producing less accurate results. This procedure solves another problem since it makes the numeric instances more balanced and reduces the risk of imprecision of computation.

$$Z_{ij} = \frac{(X_{ij} - \overline{X_j})}{\hat{\sigma}_j} \quad (23)$$

The variables are standardized using the formula in (23) where the standardized result (Z_{ij}) for indicator j of i-th stock is calculated as the difference between the value of the indicator in i-th stock (X_{ij}) and the average of the indicator for all stocks ($\overline{X_j}$) divided by the standard deviation of the indicator j for all the stocks in the sample ($\hat{\sigma}_j$). Following the standardization, the data is re-scaled using the formula in (24):

$$RZ_{ij} = Abs(min\, Z_j) + Z_i \quad (24)$$

Where RZ_{ij} is the re-scaling for each j attribute, and the results are normalized by dividing all the attributes by the respective maximum as shown in (25).

$$MRZ_{ij} = \frac{RZ_{ij}}{Max\, RZ_{ij}} \quad (25)$$

The number of variables is further expanded to include several financial indicators following (Gardijan & Škrinjarić , 2015) such as debt ratio (DR as an input variable), current liquidity ratio (CL), return on equity (ROE) and stock turnover (T) as output variables since greater values of these indicators are desirable to investors. However, since these financial indicators are usually calculated on an annual basis, calculated weekly return and volatility data is averaged to annual values. Summary statistics incorporating financial indicators is presented in Table 2, while average correlation of variables for the whole period are given in the Table 3. Financial indicators included in the model were standardized, rescaled and normalized using formulas from (23) to (25).

Table 2 Variables summary statistics for the observed period

	Standard deviation	*Debt ratio*	*Return*	*ROE*	*Current liquidity ratio*	*Turnover (HRK)*
Average	4,49%	52,47%	0,15%	32,46%	1,73568	439.991
St. Dev.	7,54%	18,88%	0,70%	75,96%	1,348746	457.609
Maximum	70,59%	104,05%	4,88%	308,61%	10,36755	2.324.131
Minimum	0,96%	15,46%	-1,77%	-261,76%	0,04868	9.451

Source: Author's construct based on Zagreb Stock Exchange trading data ZSE (www.zse.hr), and financial statements data in the period from January 2016 until December 2021.

From Table 2 it is visible that the average yearly return is just 0, 15%, maximum is just 4,88% and minimum of -1,77% for the observed period. Furthermore, the strongest correlation is between return and its volatility of 0,52 and

debt ratio (0,22) while almost no correlation was found between other observed variables as presented in the Table 3 (Correlation matrix).

Table 3 Correlation matrix of the used variables for the whole period from 2016 until 2021

Variable	*Standard deviation*	*Debt ratio*	*Return*	*ROE*	*Current liquidity ratio*	*Turnover*
Standard deviation	1	0,22	0,52	-0,12	-0,11	0,11
Debt ratio	0,22	1	-0,04	-0,05	-0,32	-0,06
Return	0,52	-0,04	1	0,07	-0,04	0,04
ROE	-0,12	-0,05	0,07	1	-0,02	-0,37
Current liquidity ratio	-0,11	-0,32	-0,04	-0,02	1	-0,11
Turnover	-0,11	-0,37	0,04	-0,06	0,11	1

Source: Author's construct based on Zagreb Stock Exchange trading data ZSE (www.zse.hr), and financial statements data in the period from January 2016 until December 2021.

Statistics in Tables 1-3 as well as Graph 1 represent the state of Croatian stock market. Even before the worst month of the observed period (March 2020 due COVID-19 disease lockdown) returns on the ZSE were small and as mentioned before, the market suffers from its shallowness and decreased liquidity. From the discussion in previous sections on the definition of risk and investors' behavior, and past empirical evidence, it is reasonable to assume investors are usually more risk and loss averse than return maximizing. Therefore, investors are more flexible on the return side (profit maximization), then on the loss side (negative returns, loss minimization). This reasoning arises from expected utility theory mentioned before (decreasing marginal utility of wealth – loss hurts more than gains make us happy). Following that, it is reasonable to assume that investors are more interested in minimizing risk (in our case standard deviation and debt ratio) at a given level of return than, maximizing them.

4. Results

Using data presented in the previous section, a static input-oriented DEA methodology was implemented using constant (CCR model) and variable returns to scale (BCC model). The efficiency results are presented in the following Tables 4 and 5. Efficiency results in Table 4 for the CCR model that assumes constant returns to scale show that only one stock (HT) is deemed efficient throughout the observed period. In this case, an efficient stock is providing the smallest risk in retrospect to the return attained. The second-best overall score is of the general CROBEX index which makes sense since it incorporates up to 30 most liquid stocks on the ZSE. This means that investing in the general stock index CROBEX is a valuable investment option in minimizing risk for retail investors, whose financial knowledge, expertise, and time is limited. Finally, there is a clear drop in efficiency in 2020 due to the COVID-19 pandemic. Otherwise, efficiency results are mixed and pretty low for the rest of the sample.

Table 4 Efficiency results using CCR input oriented model in the period from 2016 until 2021

Stock / Year	*2016*	*2017*	*2018*	*2019*	*2020*	*2021*	*Average*	*Std. Dev.*
CROBEX	94,99%	100,00%	100,00%	100,00%	65,53%	100,00%	93,42%	12,61%
CROBEXindu	48,20%	29,33%	28,98%	28,45%	50,14%	22,52%	35,29%	9,87%
CROBEXKons	35,48%	46,56%	7,03%	11,07%	6,21%	5,57%	18,28%	16,55%
CROBEXnutr	46,97%	28,36%	100,00%	18,91%	60,57%	71,93%	52,95%	26,36%
CROBEXturi	63,63%	100,00%	75,55%	92,36%	29,52%	33,03%	65,20%	27,58%
ADPL	42,12%	93,61%	31,84%	43,25%	30,19%	23,28%	43,76%	23,48%
ADRS	73,92%	100,00%	64,28%	100,00%	11,03%	43,94%	74,87%	31,84%
ARNT	30,06%	85,76%	100,00%	100,00%	24,78%	18,76%	59,06%	36,82%
ATGR	100,00%	56,32%	32,70%	58,92%	100,00%	63,00%	64,00%	27,20%
ATPL	17,61%	31,60%	8,29%	10,13%	18,78%	11,22%	16,27%	7,85%
DLKV	17,20%	21,77%	6,77%	8,07%	35,10%	2,11%	15,17%	11,08%
ERNT	40,30%	40,36%	33,65%	33,69%	67,27%	61,19%	44,68%	11,95%
HT	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%	0,00%
KOEI	100,00%	69,19%	48,87%	39,83%	51,64%	30,78%	56,72%	22,64%

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KRAS	64,95%	44,35%	30,17%	38,47%	44,34%	100,00%	53,71%	23,21%
MAIS	31,83%	22,60%	50,20%	100,00%	31,27%	94,06%	54,77%	30,60%
PODR	50,00%	17,48%	59,45%	27,85%	52,73%	21,62%	38,19%	16,40%
RIVP	51,33%	17,51%	25,77%	17,59%	25,96%	19,80%	26,33%	11,71%
VLEN	11,06%	32,57%	8,80%	18,48%	49,06%	24,35%	24,05%	13,73%
ZABA	34,14%	24,11%	24,07%	22,58%	61,60%	23,82%	31,42%	14,10%
Average	52,69%	53,07%	46,82%	48,48%	45,79%	43,55%	48,41%	3,48%
Std. Dev.	27,72%	31,15%	32,32%	34,97%	24,98%	32,68%	30,96%	3,59%

Source: Author's construct based on Zagreb Stock Exchange trading data ZSE (www.zse.hr), and financial statements data in the period from January 2016 until December 2021.

In Table 5 efficiency results for the BCC model that assumes variable returns to scale are presented. The results are higher by the nature of the model, and if a stock was efficient in the CCR model, it will be efficient in the BCC model. Improvements in the efficiency results are seen across the board, however the touristic and nutrition indices show above average efficiency, as well as ATGR, ARNT, ADRS, KOEI or the biggest companies from touristic, nutrition and industry sectors.

Table 5 Efficiency results using BCC input-oriented model in the period from 2016 until 2021

Stock / Year	***2016***	***2017***	***2018***	***2019***	***2020***	***2021***	***Average***	***Std. Dev.***
CROBEX	100,00%	100,00%	100,00%	100,00%	78,90%	100,00%	96,48%	7,86%
CROBEXindu	63,07%	32,49%	30,33%	30,71%	60,40%	28,62%	40,94%	14,77%
CROBEXKons	100,00%	100,00%	7,41%	14,12%	100,00%	5,86%	54,57%	45,51%
CROBEXnutr	47,13%	28,54%	100,00%	70,60%	68,77%	100,00%	69,17%	25,95%
CROBEXturi	100,00%	100,00%	94,75%	100,00%	30,80%	33,38%	76,49%	31,46%
ADPL	81,46%	100,00%	42,86%	43,60%	37,79%	23,51%	54,87%	26,74%
ADRS	100,00%	100,00%	100,00%	100,00%	11,06%	65,14%	79,37%	33,09%
ARNT	71,94%	100,00%	100,00%	100,00%	28,03%	20,70%	70,11%	33,90%
ATGR	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%	0,00%
ATPL	100,00%	100,00%	8,58%	10,44%	27,15%	100,00%	57,70%	42,72%
DLKV	19,26%	44,31%	8,62%	8,74%	50,41%	100,00%	38,56%	31,90%
ERNT	43,62%	40,90%	47,90%	100,00%	100,00%	100,00%	72,07%	28,00%
HT	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%	0,00%
KOEI	100,00%	95,30%	48,97%	59,42%	55,63%	100,00%	76,55%	22,15%
KRAS	68,34%	45,89%	30,33%	100,00%	54,17%	100,00%	66,46%	26,25%
MAIS	31,87%	34,83%	71,36%	100,00%	37,40%	97,86%	62,22%	29,06%
PODR	50,18%	18,54%	100,00%	75,50%	54,08%	96,81%	65,85%	28,40%
RIVP	100,00%	100,00%	100,00%	17,83%	31,43%	23,59%	62,14%	38,06%
VLEN	58,59%	100,00%	9,62%	25,47%	100,00%	100,00%	65,61%	37,29%
ZABA	77,14%	24,53%	33,77%	22,67%	73,82%	27,13%	43,18%	23,12%
Average	75,63%	73,27%	61,73%	63,96%	59,99%	71,13%	67,62%	5,98%
Std. Dev.	25,96%	32,78%	37,20%	36,82%	28,26%	36,22%	17,19%	12,16%

Source: Author's construct based on Zagreb Stock Exchange trading data ZSE (www.zse.hr), and financial statements data in the period from January 2016 until December 2021.

5. Conclusion and Recommendations

In this paper the focus of was decision-making under risk from establishing the theoretical background of theories developed to explain human, and subsequently investor's decision-making under risk. Furthermore, the goal was to identify efficient (in terms of risk) investment options on the Croatian capital market using selected stocks and stock indexes. Efficiency results from non-parametric DEA methodology show that even among the most liquid stocks on the ZSE there are but a few investment options. While average weekly returns in the observed period were, lower

than expected, general CROBEX index proved to be an efficient investment option in terms of risk minimization, which could be a viable investment strategy for retail investors. However, the use of static DEA models in this paper is suboptimal, the use of dynamic and stochastic models in future studies could be proven beneficial in gathering more insight on the investment options and strategies on a shallow and illiquid capital market such as the Croatian capital market.

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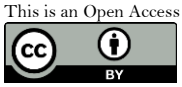

Appendix

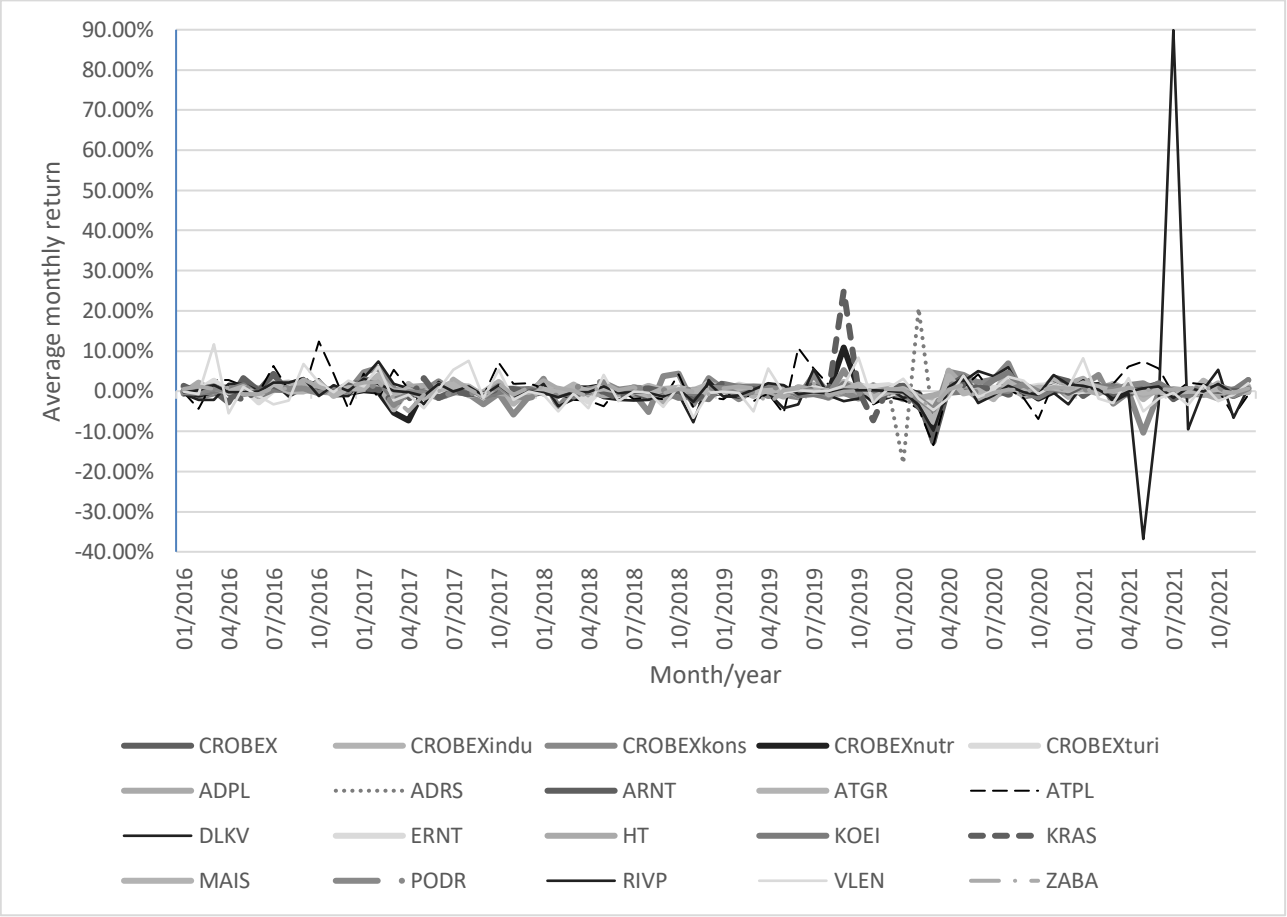

Figure 1 Monthly returns of selected stocks and stock indices on the ZSE in the period from January 2016 until December 2021

Source: Author's construct based on Zagreb Stock Exchange trading data ZSE (www.zse.hr) in the period from January 2016 until December

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