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Abstract

Our paper aims to assess whether golden ratio-based leverage targeting is linked to better ESG performance. To answer this research question, we examine the temporal dynamics of leverage in relation to the golden ratio-based leverage targets and study the relationship between golden ratio-based leverage targeting and the ESG performance in a cross-sectional setting. Our main findings show that firms choose to have a book leverage closer to the golden ratio-based leverage targets, when they have a better ESG performance. In addition, golden ratio-based leverage targeting is related to better governance pillar performance in the manufacturing sector, better social pillar performance in the service sector, and better environmental pillar performance in the trade sector. In conclusion, golden ratio-based leverage targeting is predominantly attributed to sector-specific characteristics and heuristic managerial decisions, which ties leverage to the important levels applied by the competitors.

Keywords: capital structure, golden ratio, target leverage, ESG performance

Introduction

The current evolution of business is often described as a shift from the long-dominant concept of shareholder value maximization to a more stakeholder-centric model, where the needs of multiple stakeholders, including employees, consumers, investors, communities, and our environment, are taken into account. Mapping the different manifestations of purpose based on these stakeholders provides a simple way to understand how they can work together, in harmony, towards a higher purpose. Pursuing stakeholder value creation can benefit firms in various ways, including lowering the cost of capital and mitigating the information asymmetry, which allows firms to raise capital more efficiently (Adeneye, Kammoun, and Ab Wahab 2022).

In the corporate world, CSR (corporate social responsibility), ESG (environmental, social, and governance factors), sustainability, purpose marketing, diversity, and inclusion are concepts and policies that aim to make companies and organizations more sustainable, ethical, and socially responsible. The key to success in today's purpose-driven world is to align these areas around a powerful and inspiring goal, whereby the impact is much stronger than focusing

on a myriad of disparate objectives and issues. Therefore, they become parts of a whole, pointing towards a harmonious, unified goal rather than sporadic units in a sub-optimal arrangement. The ESG framework and metrics attempt to capture this higher purpose and provide an efficient tool to measure stakeholder value creation and the sustainability of investments. Bilyay-Erdogan (2022) argues that better ESG performance reduces information asymmetry, especially in civil law and stakeholder-oriented countries. Adeneye, Kammoun, and Ab Wahab (2022) show that due to the benefits of stakeholder orientation firms can increase their book leverage and improve the speed of adjustment to reach their target leverage at a higher pace.

In this article, we aim to assess how leverage targeting is linked to ESG performance from the perspective of the Divine Proportion or 'golden ratio', the irrational number that connected mathematicians, biologists, artists, musicians, historians, architects, psychologists, and even mystics throughout the centuries, who have investigated and discussed its unexpected presence in the most diverse fields including the stock markets.

Many studies examined the link between ESG performance and the firm value or financial performance. Friede, Busch, and Bassen (2015) aggregated the results of 2000 studies and found that a large majority of the studies found a positive relationship between ESG performance and corporate financial performance. Weston and Nnadi (2021) also point out that firms that follow the principles of responsible investing (PRI) outperform those that do not. Alfalih (2022) posits that ESG disclosure practices significantly impact corporate financial performance directly and indirectly concerning the ROA and Tobin Q measures. Gregory (2022) observes that ESG scores positively affect market capitalization. Fuente, Ortiz, and Velasco (2022) find a strong positive relationship between the governance pillar and the fundamental value of equity. Instead of examining how ESG performance affects financial performance or the firm value, we attempt to contribute to the literature that explains how the choice of target leverage is linked to ESG performance.

Our research question posits that firms have better ESG performance in those financial years when their leverage is closer to the golden ratio-based leverage targets. Thus, we argue that golden ratio-based leverage targeting is linked to better ESG performance. Our results show that US and European listed firms in the manufacturing sector tend to follow golden ratio-based leverage targets considering both market and book leverage. The 23.6% in the case of book leverage and the 38.2% in the case of market leverage represent the mean leverage in the manufacturing sector, which firms tend to pursue as target leverage. Additionally, we find

evidence that in financial years, when the firms have better ESG performance, their book leverage is closer to the golden ratio-based leverage target, especially in the manufacturing and service sectors. When firms have better governance pillar performance in the manufacturing sector and better social pillar performance in the service sector, they tend to follow the golden ratio-based book leverage target. When firms have better environmental pillar performance in the trade sector, they tend to follow the golden ratio-based market leverage target. In the case of the manufacturing sector, we argue that golden ratio-based leverage targeting is attributed to sector-specific characteristics.

As the main contribution of the paper, we show that when firms have better ESG performance in the manufacturing and service sector, they apply golden ratio-based leverage targeting, which contradicts the findings of Adeneye, Kammoun, and Ab Wahab (2022) in the ASEAN countries, which pointed out that firms with better ESG performance have higher leverage targets due to the benefits of stakeholder orientation. To justify the originality of the paper, we argue that when firms have better ESG performance, they make a heuristic managerial decision to apply golden ratio-based leverage targeting, which ties their leverage to crucial levels chosen by other firms. In addition, we show that in the case of US and European listed firms in the manufacturing sector, golden ratio-based leverage targeting implies a mean reverting behavior attributed to the sector-specific characteristics. In previous research, Ulbert, Takács, and Csapi (2022) showed that golden ratio-based leverage targeting can boost the financial performance and the market acceptance of the firms. We contribute to that literature by showing that golden ratio-based leverage targeting is related to better ESG performance.

Our paper proceeds as follows: After introducing the relevant research areas (ESG, capital structure, golden ratio) and developing our hypotheses, we present our empirical results on ESG performance and golden ratio-based leverage targeting. We conclude the paper by analyzing the practical and theoretical implications of the results.

Related literature and hypothesis development

Golden ratio-based leverage targeting

Previous literature presents several business applications of the golden ratio, with a particular emphasis on management, marketing, operations management, finance, and accounting. Kulis and Hodzic (2020) published a comprehensive literature review that addresses the interdisciplinary nature of these applications. Findings relevant to the present study can be connected to Rehwinkel (2016), Ulbert, Takács, and Csapi (2022), and Amin and

Cek (2023). Rehwinkel (2016) combined the principles of the constructal law, the golden ratio, and the second law of thermodynamics. The study claimed that firms exhibit a tendency to gravitate towards their maximum debt without bankruptcy. The author found that firms in the basic material and consumer goods sector arrange their capital structures according to the constructal law. Symmetry has a fundamental role in the realms of corporate financial reporting and financial risk analysis since it is inherent in the foundational accounting equation. Consequently, it significantly influences the formulation and comprehension of corporate capital structures. The author reached the conclusion that by incorporating the constructal law, the golden ratio, and the second law, it is feasible to establish a multidisciplinary framework that enables the disclosure and analysis of capital structure formations inside business entities and sectors.

In their study, Ulbert, Takács, and Csapi. (2022) employed the golden ratio to examine the impact of its utilization in the capital structure of manufacturing and service organizations. The objective was to assess how a golden ratio-based capital structure can boost the financial performance and the market acceptance of firms. The research found a positive relationship between golden ratio-based capital structure and the financial performance of listed firms. The authors showed that the golden ratio defines important levels of equity to total assets ratio, according to which firms formulate their capital structure, especially in the case of US listed firms and the service sector. Amin and Cek (2023) strengthen these findings concerning Tobin's Q, EPS, ROA, and ROE measures.

The term "proportion" typically refers to the equilibrium or symmetry that is present among the elements of a group or between a specific element and the group as a whole (Haylock 2006). There are several distinct forms of proportionality, including mathematical, geometric, and harmonic proportions (Kotliar 2016). However, it is noteworthy that the value of 1.618 is present throughout all these different types of proportionality. The German mathematician Martin Ohm introduced the term 'golden ratio' in 1815 to refer to the divine proportion, known as the 'Goldener Schnitt' in German. The golden ratio is an irrational number characterized by its non-recurring decimal representation. Specifically, it is the only number for which the decimal component, which follows the decimal point, is equal to that of its square and its inverse. This may be observed in the values of $\varphi^2 = 2.61803398874$ and $1/\varphi = 0.61803398874$ (Ulbert, Takács, and Csapi 2022). Over the centuries, it connected mathematicians, biologists, artists, musicians, historians, architects, psychologists, and even mystics, who have studied and

discussed its unexpected presence in a wide variety of fields, including the stock markets (Urmantsev 2009).

Previously, lots of studies examined capital structure decisions and leverage targeting. Choosing a leverage target is a crucial consideration in a firm's financing policy. It plays a significant role in corporate financial performance and value creation opportunities since it is one of the main drivers of the weighted average cost of capital (WACC) calculations. The mainstream capital structure theories aim to define the optimal capital structure in cross-sectional settings. At the same time, the literature on leverage targeting tries to capture how firms reach their optimal capital structure through time, concentrating on the speed of leverage adjustment. Before reviewing the existing literature on ESG performance and the relationship between the affected variables, it is important to summarize the utilized capital structure theories to understand better and discuss how golden ratio-based leverage targeting relates to the existing theories.

The classic trade-off theory aims to maximize the firm's value with the most beneficial leverage level (Kraus and Litzenberger 1973). By applying trade-offs for the highest benefits, companies decide about a mix of equity and debt financing. Trade-off theory states that leverage is optimal if the firm value is maximized. Thus, it argues that firms can define their leverage targets based on these trade-offs.

Agency theory focuses on the connection and interests of the owners, i.e., the shareholders and the management, the so-called agent Jensen and Meckling (1976). It deals with the problem of maximizing the value of the company due to the different interests, information problems, and misunderstandings about the roles between control and ownership. Only by minimizing agency problems and reducing non-essential costs can a company maximize its value or at least move closer to that goal. Establishing a healthy and productive relationship between owners and management is essential to maximizing shareholder value and operating efficiently and profitably. Capital structure decisions are influenced by various agency issues with stakeholders, such as conflicts between managers and executives (Grabinska et al. 2021; Khatib et al. 2021). In addition, the decision to use debt or equity affects the firm’s performance and practices (Dawar 2014). According to agency theory, capital structure decisions are associated with greater information disclosure, especially due to conflicts arising from borrowing (Albers and Guenther 2010; Zamil et al. 2021). In this regard, highly leveraged firms incur greater agency costs due to capital transfers from debt holders to shareholders. By increasing the level of information disclosure, companies can prevent potential conflicts of

interest between creditors and owners and reduce agency costs (Khatib et al. 2021). Regarding the agency theory firms, the leverage is optimal if it minimizes the agency cost of debt and equity.

The pecking-order theory introduces a hierarchy of how companies handle capital (Myers 1984). The responsibility for determining the target leverage does not lie with managers; nonetheless, they employ capital sources in a specific sequence, beginning with internal funds, followed by debt issue, and ultimately, equity offering. Pecking-order theory states that firms first fund their financial deficit with debt before using external equity.

Lots of studies examined the sector-specific nature of capital structure. Ross, Westerfield, and Jaffe (2008) argue that the optimal level of leverage differs significantly across industries. Frank and Goyal (2009) explain the sector-specific capital structure with the decisions of the management, which considers the median leverage of the sector as the leverage target. On the other hand, Hovakimian, Opler, and Titman (2001) pointed out that firms actively adjust their leverage towards the sector average.

Companies strive to achieve the optimal capital structure, which maximizes firm value at the lowest cost. By testing the empirical validity of capital structure theories, Dang (2011) finds that listed firms tend to follow a leverage target, but due to market frictions like asymmetric information, they cannot reach their targets immediately. However, their leverage converges towards the target dynamically. Adeneye, Kammoun, and Ab Wahab (2022) also find that the leverage of the firms converges towards their leverage targets. The speed of adjustment usually varies due to market frictions. These findings empirically support the assumptions behind the trade-off theory against the other capital structure theories pursuing the optimal capital structure. In contrast to these findings, Moradi and Paulet (2019) present empirical evidence that validates the assumptions of pecking-order theory and agency cost theory and emphasize that the Euro Crisis significantly affected leverage upon examining the firm-specific characteristics of capital structure.

Concerning the golden ratio-based capital structure, Ulbert, Takács, and Csapi (2022) argue that firms adjust their leverage towards important levels defined by the golden ratio. In this theory, the choice of a golden ratio-based target leverage can be considered a heuristic managerial decision. The findings about golden ratio-based capital structure can complement the theories about optimal capital structure very well but contradict the dynamic capital structure theories, which assume that target leverage changes constantly according to the different firm-level attributes. To answer our research question, we argue that US and European

listed firms apply golden ratio-based leverage targeting. We assume that firms actively adjust their market and book leverage towards the important levels defined by the golden ratio.

H1: Firms actively adjust their leverage towards the important levels defined by the golden ratio.

H1a: Firms actively adjust their market leverage towards the important levels defined by the golden ratio.

H1b: Firms actively adjust their book leverage towards the important levels defined by the golden ratio.

ESG and the capital structure

Corporate goals and mission statements have changed dramatically over the past 100 years. The transition from a one-dimensional shareholder orientation (Friedman 1970) to a multi-dimensional stakeholder orientation has given rise to what is known as "stakeholder capitalism". A stakeholder is any group or individual that can influence or is influenced by an organization's performance (Freeman 1984). Stakeholders include customers, suppliers, employees, creditors, managers, communities, the environment, and governmental actors. The concept of stakeholder capitalism argues that companies maximize their long-term value, taking into account the interests of all stakeholders, not just the interests of shareholders.

In the past, investors were willing to pay primarily for tangible assets to acquire real estate, whereas today, the value of companies is largely composed of intangible assets such as reputation, corporate culture, or customer loyalty. In addition, the public perception of companies as pure financial market participants has shifted to players that contribute to the well-being of society and the environment.

The three concepts of sustainability, CSR (corporate social responsibility), and ESG (environmental, social, and governance) are more frequently used than ever in research and in business practices as well. It is extremely common for the above terms to be used interchangeably and synonymously. However, alongside the similarities, there are also crucial differences. Generally speaking, there are fundamental differences in the purpose behind the terms. Perhaps the broadest of the three terms is sustainability. The definitions of sustainability are endless. In 1987, the United Nations Brundtland Commission defined sustainability as "meeting the needs of the present without compromising the ability of future generations to

meet their own needs." Sustainability is usually referred to as an umbrella term that includes several other concepts, such as CSR and ESG.

CSR was first defined in the 1950s by Bowen (1953), who referred to it as the responsibility of companies to address the needs of society as a whole. Caroll (1979) divided the phenomenon of CSR into three circles, taking into account economic, legal, ethical, and discretionary (later modified to philanthropy) issues. In order to meet CSR requirements, companies try to generate profits, meet legal requirements, take ethical issues into account, and ultimately strive for good corporate citizenship.

The term ESG was first used in 2004. ESG is based on three pillars. The symbol E is the environmental criterion, which includes the energy used by the company, the waste produced, the resources required, and the consequences of using them as an outcome. Last but not least, it encompasses carbon emissions and climate change. S is the social criterion, which refers to the company's relationships and reputation in the communities and institutions where it operates. It includes labor relations, diversity, and inclusion. G refers to corporate governance, the adaptation of practices, controls, and procedures to manage and make effective decisions in accordance with the law and to meet the needs of external stakeholders. ESG (Environmental, Social, Governance) codifies these aspects for investors and shareholders in a transparent and measurable way that allows comparison between companies. It is a useful tool that helps to articulate the company's commitments to environmental and social objectives in an accountable and tangible way. ESG-based business practices include adopting sustainable practices, supporting social causes, and promoting ethical business behavior.

There are significant changes in ESG priorities in the business community, driven not only by the pandemic but also by economic downturns, social unrest, and extreme weather events. Focusing on multi-stakeholder interests and ethical business practices is essential for businesses to succeed in a modern and dynamic environment. The stakeholder model of Kay, Brindisi, and Martin (2020) captures the reaffirming translation of stakeholder contributions to the economic success of the firm. All companies must balance the long-term interests of stakeholders, including shareholders. When companies effectively manage the trade-offs between short- and long-term performance, they support an optimistic stakeholder value chain outcome.

Engaging in ESG activities has an effect not only from an external perspective but also on the internal financial structure. Thus, ESG performance can influence capital structure decisions, and capital structure decisions have a mediating role in the perceived relationship

between uncertainty, CSR and/or ESG performance, stakeholder interest, and financial performance (Hunjra, Verhoeven, and Zureigat 2020). Therefore, the firms' capital structure choice is in the interest of many stakeholders, such as shareholders, investors, and debtholders (Dincer 2011; Hamid, Abdullah, and Kamaruzzamanc 2015).

Previous literature argued that the relationship between firm value and ESG performance is positive due to the fact that better ESG performance can result in higher market valuation and lower cost of capital as shareholders accept lower returns, and debtholders can mitigate the problems of asymmetric information. Due to this fact, firms with higher ESG performance can have higher target leverage and a higher speed of adjustment (Adeneye, Kammoun, and Ab Wahab 2022).

The indisputable observation of good outcomes resulting from engagement in ESG activities is evident in the published papers regarding the cost of equity. The findings demonstrate a distinct inverse correlation between ESG performance and the cost of equity, indicating that augmenting investments in ESG practices and enhancing their transparency will result in a reduction in the cost of equity. The primary factor contributing to this occurrence, namely the constraint of asymmetric information, has been further explored in many studies, including those undertaken by Matthiesen and Salzmann (2015) as well as Ng and Rezaee (2015). Additionally, according to a survey conducted by PriceWaterhouseCoopers (2014), it was observed that the utilization of Environmental, Social, and Governance (ESG) standards is associated with a reduction in company risk, leading to a fall in the cost of equity. According to a separate poll by Armitage and Marston (2008), there was a notable emphasis on the importance of improved transparency. This emphasis is expected to result in reduced risk and a decrease in the cost of equity. According to the research conducted by Sharfam and Fernando (2008), it was seen that the management of environmental risk led to a decrease in beta and stock volatility. Ferris, Javakhadze, and Rajkovic (2017) found a correlation between management social capital and sharing information with stakeholders in a company. This correlation aligns with previous research, leading to increased knowledge and decreased information asymmetry.

Table 1.: ESG and the determinants of capital structure in the existing empirical literature

	ESG		
	+	-	0
Cost of equity		Matthiesen and Salzmann (2015) Ng and Rezaee (2015) PriceWaterhouseCoopers (2014) Armitage and Marston (2007) Sharfam and Fernando (2008) Ferris, Javakhadze, and Rajkovic (2017) Cantino, Devalle, and Fiandrino (2017)	
Cost of debt	Li, Zhou, and Xiong (2020) **(E)** Goss and Roberts (2011)	Li, Zhou, and Xiong (2020) **(S, G)** Arora and Sharma (2022) **(S)** Chen, Kacperczyk, and Ortiz-Molina (2011) Ge and Lui (2015) Cooper and Uzur (2015) Hoepner (2016) Weber, Scholz, and Michalik (2008) Weber, Diaz, and Schwegler (2012) Gracia and Siregar (2021)	Kjerstensson and Nygren's (2019) Gracia and Siregar (2021)
Book leverage	Adeneye, Kammoun, and Ab Wahab (2022) Al Amosh et al. (2022) Krištofík, Medzihorský, Musha (2022)		
Market leverage		Adeneye, Kammoun, and Ab Wahab (2022)	
Speed of adjustment	Adeneye, Kammoun, and Ab Wahab (2022)		

Cantino, Devalle, and Fiandrino (2017) provided a comprehensive overview of the relationship between the cost of debt and CSR or ESG activities. In their empirical literature review, the examined studies were distinguished based on the specific area of focus. The initial cohort directed their attention toward the financial implications associated with corporate bonds, whereas the subsequent group addressed the subject matter pertaining to loans. The findings yielded ambiguous results and lacked uniformity. In relation to the domain of bonds, Weber, Scholz, and Michalik (2008); Chen, Kacperczyk, and Ortiz-Molina (2011); Weber, Diaz, and Schwegler (2012); Ge and Lui (2015); and Al Amosh et al. (2022) observed that the inclusion and transparency of ESG activities led to a favorable outcome, namely the ability to issue bonds at a reduced cost. The fundamental rationale for their decision encompassed the advantages of enhanced credit scores, the implementation of policies aligned with environmental, social, and governance (ESG) principles, and the establishment of stronger connections with creditors. Focusing on Nordic countries, Kjerstensson and Nygren (2019)

showed that the required risk premium did not decrease concerning higher ESG ratings. So, for them, a higher ESG score did not provide a lower cost of debt. Gracia and Siregar (2021) concentrated on the so-called ASEAN countries (Indonesia, Malaysia, the Philippines, Singapore, and Thailand) while differentiating sustainability performance (sustainability activities) and sustainability disclosure (the way of communication with stakeholders about sustainability activities). Based on their findings, with better sustainability disclosure, firms achieved lower costs of debt. On the other hand, without sustainability disclosure, there was no significant relationship with the cost of debt. According to them, companies can reduce information asymmetry and provide more information for debt providers with better sustainability disclosure.

When considering loans obtained from financial institutions, the presence of a disagreement remained evident. Goss and Roberts (2011) observed that banks possessed a greater amount of information both before and during the duration of the business relationship with enterprises. However, ESG activities and CSR initiatives were not perceived as factors that mitigate risk by the banks and, therefore, were not given significant value or recognition. The researchers also conducted a more detailed examination of individuals classified as low-quality borrowers who experienced a disadvantage in the form of increased expenses rather than receiving benefits due to corporate social responsibility initiatives. Enterprises deemed to be of good quality were exempt from additional penalties. However, Cooper and Uzur (2015) and Hoepner (2016) obtained contrasting findings while analyzing commercial banks as stakeholders. The significance of CSR and ESG commitment was emphasized as being influential from the banks' standpoint. It was observed that a stronger emphasis on CSR practices corresponded to a decrease in the cost of debt.

Individually concentrating on the ESG pillars, Li, Zhou, and Xiong (2020) discovered a positive correlation between bond default rate and energy consumption and use but a negative correlation with social responsibility and governance. While emphasizing the significance of stakeholder theory, Arora and Sharma (2022) discovered the possibility of reducing the cost of debt through ESG activities in countries such as India. They determined that social factors from the environmental, social, and governance pillars had the greatest influence on the cost of debt reduction.

Expanding the perspective on decision-making concerning the capital structure is a valuable endeavor, particularly in light of the influence of leverage and the speed at which adjustments are made to achieve target leverage while taking into account the observability of environmental, social, and governance engagement. The study conducted by Al Amosh et al. (2022) indicate a clear preference among Jordanian enterprises for debt financing over equity finance in the case of ESG activities. The researchers found that ESG performance showed improvement when financed by debt across all dimensions of ESG. In contrast, equity financing did not affect ESG performance noticeably. Krištofík, Medzihorský, and Musha (2022) targeted top European companies with their research and found that companies involved in sustainability are more leveraged than those who did not have such incentives and investments. Companies tend to refrain from utilizing equity for ESG investments since this allows them to mitigate the inclusion of new shareholders who might possess divergent interests compared to the companies themselves. These authors suggested that a greater degree of equity would be associated with a more beneficial disposition towards shareholders and a more extensive dispersion of authority. However, by following this line of reasoning, the interests and demands of other stakeholders would also need to be taken into account, potentially leading to conflicts of interest and undermining the efficacy of ESG initiatives. Cantino, Devalle, and Fiandrino (2017) suggested that in the case of CSR companies, the cost of equity was lower than that of companies without CSR. Benlemlih (2017) observed a reverse pecking order theory for CSR companies. These studies clearly emphasize equity utilization.

Adeneye, Kammoun, and Ab Wahab (2022) conducted a study suggesting that book leverage and ESG scores are positively related, so firms increased their debt usage with socially responsible behavior. They also added that this phenomenon provided better access to debt due to the increased confidence and trust among stakeholders because of the ESG disclosure and increased transparency. They also found that the higher the incentive for ESG-related activities, the higher leverage was more beneficial for companies. On the other hand, they gained a significant negative relationship between ESG scores and market leverage, which they assumed to be related to the accuracy of the available market values.

Concerning the speed of adjustment (SOA) to target leverage, no matter which pillars of ESG scores are investigated, the speed of adjustment is faster with the presence of ESG than without it (Adeneye, Kammoun, and Ab Wahab 2022). Analyzing the pillars separately, the SOA with ESG presence was 3.41% higher than without ESG scores, while by distinguishing between the pillars, environmental was 7.82% faster, social by 2.88%, and governance by

0.47%. The numbers presented accurately show that environmental activities had the largest influence on the speed of adjustment from the three different areas of sustainability.

The cited papers altogether demonstrate that conducting research on a given subject with almost identical factors can provide both convergent and controversial findings. The widespread adoption of sustainable operations has been increasingly documented in response to new regulations and policies or external pressures, demanding companies to address this phenomenon. Nevertheless, determining how ESG performance influences capital structure resulted in contradictory results. What does the optimal capital structure consist of, and what is the optimal ratio between equity and debt when considering ESG performance? According to the available reports, participation in environmental, social, and governance (ESG) initiatives can mitigate financial risk and information asymmetry, resulting in lower cost of equity, better financial performance, and higher firm value.

On the other hand, concerning the capital structure decisions, we can find contradictory results on whether to include more equity or debt in the financing mix. The presence of non-identical conclusions introduces complexity and uncertainty into the decision-making processes of firms, as well as those of internal and external decision-makers and other stakeholders. Identifying an optimal capital structure allocation is of major importance to effectively address a wide range of interests.

Is it possible to address the issue of the above reviewed imbalanced or asymmetric capital structure decisions in the presence of ESG activities while also considering the preferences of the company's stakeholders? We propose that applying the golden ratio-based leverage targeting represents a valuable method for evaluating this matter. Based on current understanding, there is a lack of comprehensive scientific research about the potential impacts associated with the integration of the golden ratio into the decision-making processes of companies' capital structures in the context of their engagement in environmental, social, and governance (ESG) initiatives that target diverse stakeholders.

We argue that when firms have better ESG performance, they instead make a heuristic managerial decision to apply golden ratio-based leverage targeting instead of assessing the benefits of using equity or debt, which ties the target leverage to crucial levels other firms apply. Thus, golden ratio-based leverage targeting is linked to better ESG performance.

H2: When firms have better ESG performance, they choose to have a leverage closer to the important levels defined by the golden ratio.

H2a: When firms have better ESG performance, they choose to have a market leverage closer to the important levels defined by the golden ratio.

H2b: When firms have better ESG performance, they choose to have a book leverage closer to the important levels defined by the golden ratio.

Research design

Sample selection and descriptive statistics

The sample chosen for this study comprises publicly traded firms originating from Europe and the United States. The inclusion criteria for these firms were based on the availability of both their environmental, social, and governance (ESG) scores and financial data from Refinitiv Eikon. The selected time frame for data collection spans from financial years 2010 to 2021. The sample construction process involved the use of the following selection criteria: the sample exclusively comprises firms that possess ESG score data for every financial year within the chosen timeframe. We consider only the North American Industry Classification System (NAICS) sectors that align with conventional manufacturing, trade, or service characteristics while excluding industries such as agriculture, mining, real estate, finance, insurance, or utilities. According to the provided excerpt, the sample comprises nine sectors. We include only those firms in the sample whose financial year ends at the end of December, and whose market capitalization, total equity, and total debt exceed zero. Therefore, we just focus our analysis on the leveraged firms.

Table 2. presents the composition of our sample. We have been able to analyze 368 publicly listed firms over a span of twelve years in accordance with our predetermined selection criteria. The sample encompasses a total of 4416 financial years. The sample consists of 3432 financial years from manufacturing firms, 600 financial years from the service sector, and 384 financial years from the trade sector. Our sample consists of 2640 financial years of European listed firms and 1776 financial years of listed firms from the United States, with respect to geographical regions.

Table 2: Structure of the sample

Financial years	Manufacturing	Service	Trade	Total
Europe	2052	336	252	2640
USA	1380	264	132	1776
Total	3432	600	384	4416

Table 3. presents the conceptualization and operationalization of the variables encompassed in our analytical framework. The ESG score and ESG pillar scores are quantified using a numerical scale ranging from 0 to 100. Market leverage was computed by dividing the total debt by the sum of the total debt and market capitalization. The calculation of book leverage involves dividing the total debt by the sum of the total debt and total equity. In our analysis, we used the assumption that firms select their target leverage based on the golden ratio and that the actual leverage of firms tends to converge towards the ratios observed in the Fibonacci sequence. Thus, we compared the market leverage to 23.6%, which is $1/1.618^3$, and the book leverage to 38.2%, which is $1/1.618^2$. Upon examining whether firms actively adjust their leverage towards the important levels defined by the golden ratio, we determined the deviation from the target leverage by substracting the first lag of the leverage from the ratios to conduct a comparison between this deviation and the actual change of the leverage. Additionally, we calculated the absolute deviation of the actual ESG scores and ESG pillar scores from their maximum values over a period of 12 years. and determined the absolute deviation of the actual leverage from the target leverage in order to analyze whether golden ratio-based leverage targeting is linked to better ESG performance.

Table 3: Description of the variables

Variables	Description
$ESG_{i,t}$	ESG Score of firm i in the financial year t
$ENV_{i,t}$	Environmental Pillar Score of firm i in the financial year t
$SOC_{i,t}$	Social Pillar Score of firm i in the financial year t
$GOV_{i,t}$	Governance Pillar Score of firm i in the financial year t
$MLEV_{i,t} = \frac{Total\ Debt_{i,t}}{Total\ Debt_{i,t} + Market\ cap._{i,t}}$	Market leverage of firm i in the financial year t.
$BLEV_{i,t} = \frac{Total\ Debt_{i,t}}{Total\ Debt_{i,t} + Total\ Equity_{i,t}}$	Book leverage of firm i in the financial year t.
$MTARGET_{i,t} = 0.236 - MLEV_{i,t-1}$	Deviation of the market leverage from the golden ratio-based target leverage (23,6%) of firm i in the financial year t
$BTARGET_{i,t} = 0.382 - BLEV_{i,t-1}$	Deviation of the book leverage from the golden ratio-based target leverage (38.2%) of firm i in the financial year t
$ESGDIF_{i,t} = \lvert ESG_{i,t} - \max(ESG_i) \rvert$	Deviation of the actual ESG Score from the twelve-year maximum:
$ENVDIF_{i,t} = \lvert ENV_{i,t} - \max(ENV_i) \rvert$	Deviation of the actual Environmental Pillar Score from the twelve-year maximum:
$SOCDIF_{i,t} = \lvert SOC_{i,t} - \max(SOC_i) \rvert$	Deviation of the actual Social Pillar Score from the twelve-year maximum:
$GOVDIF_{i,t} = \lvert GOV_{i,t} - \max(GOV_i) \rvert$	Deviation of the actual Governance Pillar Score from the twelve-year maximum:
$MLEVDIF_{i,t} = \lvert MLEV_{i,t} - 0.236 \rvert$	Deviation of the actual market leverage from the golden ratio-based target leverage
$BLEVDIF_{i,t} = \lvert BLEV_{i,t} - 0.382 \rvert$	Deviation of the actual book leverage from the golden ratio-based target leverage

The descriptive statistics of the financial years are presented in Table 4. The ESG scores exhibit an average value of 59.67 points, accompanied by a standard deviation of 19.46 points. Furthermore, the mean absolute deviation of the ESG scores from the maximum values during a 12-year period amounts to 13.56 points.

The ESG pillar scores exhibit similar patterns. On average, the market leverage is observed to be 24.43%, with a standard deviation of 18.35%. Additionally, the mean absolute deviation of the actual market leverage from the golden ratio-based target is 14.03%. In contrast, the mean book leverage is 39.27%, with a standard deviation of 19.25%. The mean absolute deviation of the actual book leverage from the golden ratio-based target is 15.32%. Calculating the absolute deviations in the case of ESG scores, ESG pillars, market leverage, and book leverage allows us to examine the cross-sectional heterogeneity of the absolute deviations as we aim to assess whether golden ratio-based leverage targeting is linked to better ESG performance. Upon examining the temporal dynamics of leverage, it is observed that the leverage shown in the previous financial year deviates just a little from the target defined by the golden ratio. When examining market leverage, the observed difference is only -91 basis points on average, whereas in the context of book leverage, the difference stands at -86 basis points.

Table 4: Descriptive statistics of the financial years

Variables	Mean	Standard deviation	Minimum	Median	Maximum	Number of Observations	Lower bound (95%)	Upper bound (95%)
$ESG_{i,t}$	59.6697	19.4570	2.7058	62.3350	95.7671	4416	59.0957	60.2437
$ENV_{i,t}$	57.1176	26.4777	0.0000	61.5354	98.8863	4416	56.3365	57.8988
$SOC_{i,t}$	62.8527	22.7920	0.2635	66.9669	98.4696	4416	62.1803	63.5252
$GOV_{i,t}$	57.1071	22.0441	1.6020	59.3287	97.8189	4416	56.4568	57.7575
$MLEV_{i,t}$	0.2443	0.1835	0.0000	0.2005	0.9752	4416	0.2388	0.2497
$BLEV_{i,t}$	0.3927	0.1930	0.0000	0.3839	0.9996	4416	0.3871	0.3984
$MTARGET_{i,t}$	-0.0091	0.1834	-0.7392	0.0339	0.236	4048	-0.0148	-0.0035
$BTARGET_{i,t}$	-0.0086	0.1925	-0.6176	-0.0007	0.3820	4048	-0.0145	-0.0026
$ESGDIF_{i,t}$	13.5594	12.1404	0.0000	10.4375	75.5100	4048	13.1853	13.9335
$ENVDIF_{i,t}$	15.1268	16.0601	0.0000	10.0411	91.8908	4048	14.6319	15.6217
$SOCDIF_{i,t}$	14.8784	14.6110	0.0000	10.3434	93.4976	4048	14.4282	15.3287
$GOVDIF_{i,t}$	19.2054	15.3675	0.0000	16.3642	73.9254	4048	18.7318	19.6789
$MLEVDIF_{i,t}$	0.1403	0.1181	0.0000	0.1147	0.7392	4048	0.1366	0.1439
$BLEVDIF_{i,t}$	0.1532	0.1181	0.0000	0.1276	0.6176	4048	0.1496	0.1569

Table 5. presents the mean market and book leverage of the subsamples, together with their respective deviations from the targets as determined by the golden ratio. (Market leverage is compared to a target of 23.6%, while book leverage is compared to a target of 38.2%.) The mean market leverage ratio observed among the manufacturing companies is 23.83%, exhibiting a marginal deviation of 23 basis points from the desired target of 23.6%. The mean book leverage observed among manufacturing companies is 38.19%, exhibiting a marginal deviation of 1 basis point from the desired target of 38.2%. In the context of manufacturing firms, the differences between the mean values of leverage and the golden ratio-based targets can be considered insignificant. The mean market leverage ratio observed among service sector companies is 25.86%, exhibiting a deviation of 2.26% from the target. The difference is significantly larger, 7.42%, in the case of the book leverage of the service sector firms. The differences are significant at the 1% level. Significant differences in market leverage and negligible differences in book leverage are observed within the trade sector. Significant differences from the desired target values are observed upon examination of the regional subsamples. According to the sectoral descriptive statistics of market and book leverage, we argue that golden ratio-based leverage targeting is attributed to sector-specific characteristics, especially in the manufacturing sector.

Table 5: Golden ratio-based target leverage in the subsamples

		Variable	Mean	Standard Deviation	Number of Obs.	Lower Bound (95%)	Upper Bound (95%)	Deviation from the golden ratio-based target leverage
Type	Manufacturing	$MLEV_{i,t}$	0.2383	0.1819	3432	0.2322	0.2444	0.0023 (0.751)
		$BLEV_{i,t}$	0.3819	0.1877	3432	0.3756	0.3882	-0.0001 (-0.0328)
	Services	$MLEV_{i,t}$	0.2586	0.1825	600	0.2439	0.2732	0.0226*** (3.0279)
		$BLEV_{i,t}$	0.4562	0.2169	600	0.4388	0.4735	0.0742*** (8.3743)
	Trade	$MLEV_{i,t}$	0.2748	0.1946	384	0.2553	0.2944	0.0388*** (3.9119)
		$BLEV_{i,t}$	0.3907	0.1818	384	0.3724	0.4089	0.0087 (0.9342)
Region	Europe	$MLEV_{i,t}$	0.2548	0.2015	2640	0.2472	0.2625	0.0168*** (4.2947)
		$BLEV_{i,t}$	0.3698	0.1948	2640	0.3623	0.3772	-0.0122*** (-3.2286)
	USA	$MLEV_{i,t}$	0.2285	0.1516	1776	0.2215	0.2356	-0.0095*** (-2.636)
		$BLEV_{i,t}$	0.4269	0.1852	1776	0.4183	0.4355	0.0449*** (10.2238)

Note: t-statistic in parentheses, ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Estimated models

To examine whether firms actively adjust their leverage towards the important levels defined by the golden ratio, we proceeded by estimating the rate at which firms adjust their leverage towards these golden ratio-based targets (speed of adjustment), as outlined by equations (1) and (2). In equation (1), we regress the first difference of the market leverage on the deviation of the previous market leverage from the golden ratio-based target. In equation (2), we do the same with book leverage. These models provide insights into whether firms adjust their leverage in a manner that converges toward the golden ratio-based targets.

$$\Delta MLEV_{i,t} = \alpha_i + \beta \cdot MTARGET_{i,t} + \varepsilon_{i,t} \quad (1)$$

$$\Delta BLEV_{i,t} = \alpha_i + \beta \cdot BTARGET_{i,t} + \varepsilon_{i,t} \quad (2)$$

In order to estimate equation (1) and equation (2), the generalized method of moments (GMM) proposed by Arellano and Bond (1991) is employed. This approach is suitable for dynamic panel models when a correlation exists between the error term ($\varepsilon_{i,t}$) and the independent variable because of the first lag of the leverage. The second and third lags of the explanatory variables were employed as instruments, and Sargan's (1958) test was applied to evaluate the viability of these instruments. The second-order serial correlation is also examined in the first differenced equation. In addition, our estimation incorporates the instrument matrix transformation proposed by Roodman (2009) and the robust standard errors method introduced by Arellano (1987). These models allow us to examine the temporal dynamics of the leverage in relation to the golden ratio-based targets.

In the following analysis, we examine the relationship between the absolute deviation of the environmental, social, and governance (ESG) performance compared to the highest value in the investigated 12-year span and the absolute deviation of the actual leverage from the golden ratio-based targets, as outlined in equations (3)-(10). In these models, we explore the cross-sectional heterogeneity of the absolute deviations. Therefore, we assume that a lower absolute deviation from the target leverage is associated with a lower absolute deviation from the twelve-year maximum ESG performance in a given financial year. A positive and statistically significant γ-coefficient is anticipated, suggesting a positive association between golden ratio-based leverage targeting and ESG performance.

$$ESGDIF_{i,t} = d_t + \gamma \cdot MLEVDIF_{i,t} + \varepsilon_{i,t} \quad (3)$$

$$ESGDIF_{i,t} = d_t + \gamma \cdot BLEVDIF_{i,t} + \varepsilon_{i,t} \quad (4)$$

$$ENVDIF_{i,t} = d_t + \gamma \cdot MLEVDIF_{i,t} + \varepsilon_{i,t} \quad (5)$$

$$ENVDIF_{i,t} = d_t + \gamma \cdot BLEVDIF_{i,t} + \varepsilon_{i,t} \quad (6)$$

$$SOCDIF_{i,t} = d_t + \gamma \cdot MLEVDIF_{i,t} + \varepsilon_{i,t} \quad (7)$$

$$SOCDIF_{i,t} = d_t + \gamma \cdot BLEVDIF_{i,t} + \varepsilon_{i,t} \quad (8)$$

$$GOVDIF_{i,t} = d_t + \gamma \cdot MLEVDIF_{i,t} + \varepsilon_{i,t} \quad (9)$$

$$GOVDIF_{i,t} = d_t + \gamma \cdot BLEVDIF_{i,t} + \varepsilon_{i,t} \quad (10)$$

In order to obtain estimates for equations (3) through (10), we employ a pooled ordinary least squares (OLS) estimator with fixed effects for time. Therefore, it is possible to isolate the temporal component of our panel data and analyze the cross-sectional relationship between deviations. Additionally, robust standard errors proposed by Arellano (1987) are employed in our analysis.

Results

Golden ratio-based leverage targeting

Table 6. presents an analysis of whether firms choose target leverage based on the golden ratio. In the current analysis, we assess the convergence towards the golden ratio-based targets by region and sector. We estimate equation (1) and equation (2), where the dependent variable is the first difference of market and book leverage, which is explained by the deviation of the first lag of leverage from the golden ratio-based targets. When the estimated β coefficient equals 1, firms immediately adjust their leverage to reach the golden ratio-based target. Nevertheless, if the coefficient is positive and smaller than 1, it implies that the leverage converges towards the golden ratio-based target leverage at a relatively slower pace. We can observe that in the case

of the full sample, the speed of adjustment toward the golden ratio-based target leverage is positive and significant at the 1% level in the case of market leverage and book leverage. In addition, significant, positive coefficients are observed in both cases within the manufacturing sector of Europe and the United States.

According to the Sargan test, we can prove the viability of the instruments, and the second-order autocorrelation is not present in the models. We can find second-order autocorrelation significant at the 5% level alone in the context of the book-leverage model of the full sample and the market leverage model of the European trade sector. Based on the findings presented, we can argue that the firms actively adjust their market and book leverage towards the golden ratio-based targets. However, we believe that the dominance of manufacturing firms affects our results in the full sample.

Table 6: Golden ratio-based leverage targeting by region and sectors

	Dependent variable	Independent variable	Coefficient(β)	Number of Observations	Sargan Test: p-value	AR2 Test: p-value
Full sample	$\Delta MLEV_{i,t}$	$MTARGET_{i,t}$	0.1678*** (0.0353)	3372	0.9406	0.2110
	$\Delta BLEV_{i,t}$	$BTARGET_{i,t}$	0.0818*** (0.0300)	3372	0.8693	0.0494
Europe (Manufacturing)	$\Delta MLEV_{i,t}$	$MTARGET_{i,t}$	0.2177*** (0.0474)	1567	0.6479	0.3889
	$\Delta BLEV_{i,t}$	$BTARGET_{i,t}$	0.1256*** (0.0334)	1567	0.6270	0.7960
Europe (Services)	$\Delta MLEV_{i,t}$	$MTARGET_{i,t}$	0.1127 (0.1353)	256	0.5056	0.9575
	$\Delta BLEV_{i,t}$	$BTARGET_{i,t}$	0.0231 (0.0735)	256	0.9161	0.7190
Europe (Trade)	$\Delta MLEV_{i,t}$	$MTARGET_{i,t}$	0.1109 (0.0925)	191	0.5794	0.0166
	$\Delta BLEV_{i,t}$	$BTARGET_{i,t}$	0.0715 (0.1037)	191	0.4857	0.4431
USA (Manufacturing)	$\Delta MLEV_{i,t}$	$MTARGET_{i,t}$	0.3018*** (0.1008)	1053	0.2153	0.1104
	$\Delta BLEV_{i,t}$	$BTARGET_{i,t}$	0.1575*** (0.0519)	1053	0.2638	0.1114
USA (Services)	$\Delta MLEV_{i,t}$	$MTARGET_{i,t}$	0.1152 (0.1075)	200	0.4127	0.6362
	$\Delta BLEV_{i,t}$	$BTARGET_{i,t}$	-0.1345 (0.1589)	200	0.1966	0.9574
USA (Trade)	$\Delta MLEV_{i,t}$	$MTARGET_{i,t}$	0.1172* (0.0683)	100	0.3912	0.8034
	$\Delta BLEV_{i,t}$	$BTARGET_{i,t}$	-0.1227 (0.1992)	100	0.1228	0.9966

Note: Arellano standard errors in the parentheses ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

We argue that golden ratio-based leverage targeting is attributed to sector-specific characteristics since firms in the manufacturing sector tend to follow golden ratio-based leverage targets regardless of their geographical location. Our results align with the findings of Hovakimian, Opler, and Titman (2001), as the difference between golden ratio-based leverage targets and the mean leverage is insignificant in the manufacturing sector. Manufacturing firms actively adjust their leverage towards the sector average as it represents an important level defined by the golden ratio. These findings also strengthen our understanding that golden ratio-based leverage targeting is attributed to sector-specific characteristics and can be considered a result of heuristic managerial decisions, which ties the leverage to crucial levels other firms apply.

Golden ratio-based leverage targeting and the ESG performance

Table 7. presents an analysis of the relationship between the deviation of the actual ESG Score from the twelve-year maximum and the deviation of the actual leverage from the golden ratio-based leverage targets, as defined by equations (3) to (10). In the current analysis, we examine whether firms choose to have a leverage closer to the crucial levels defined by the golden ratio when they have better ESG performance. Thus, we study the association between the absolute deviations in a cross-sectional setting to assess whether golden ratio-based leverage targeting is linked to better ESG performance.

Positive and statistically significant coefficients are predominantly observed in relation to the book leverage. When examining the entire sample, it becomes apparent that the coefficient of book leverage demonstrates a positive and statistically significant relationship with both the ESG score (ESGDIF) and the governance pillar score (GOVDIF). If the absolute deviation from the target leverage decreases by one percentage point, the deviation of the ESG score from its twelve-year maximum decreases by 0.03 points, and the deviation of the governance pillar score decreases by 0.067 points.

Table 7: Golden ratio-based leverage targeting and the ESG performance

Dependent variable	Independent variable	Coefficient	Full sample	Manufacturing	Service	Trade	USA	Europe
$ESGDIF_{i,t}$	$MLEVDIF_{i,t}$	γ	-2.3970	-3.8504**	-0.6880	6.6594	-1.5758	0.5402
			(1.4985)	(1.7763)	(3.5719)	(4.7688)	(3.0833)	(1.7478)
		Adj. R^2 (%)	30.4358	29.2389	39.6458	26.4683	30.0901	31.8730
	$BLEVDIF_{i,t}$	γ	3.0439**	2.7327*	7.0566**	-5.0617	-0.6762	6.1625***
			(1.3460)	(1.5697)	(3.1582)	(5.3661)	(2.3001)	(1.6396)
		Adj. R^2 (%)	30.4664	29.1752	40.1428	26.2739	30.0814	32.2612
$ENVDIF_{i,t}$	$MLEVDIF_{i,t}$	γ	-1.2737	-5.0539**	4.4340	19.3116***	6.1144	1.7535
			(2.0989)	(2.4599)	(5.2403)	(7.2809)	(4.3329)	(2.4142)
		Adj. R^2 (%)	15.8144	15.9508	16.5041	12.9389	20.7562	13.3009
	$BLEVDIF_{i,t}$	γ	0.1268	1.4764	-6.2363	-1.7249	-6.2132*	5.7169**
			(2.0012)	(2.3655)	(4.5199)	(8.2841)	(3.3718)	(2.4048)
		Adj. R^2 (%)	15.8064	15.8326	16.6156	11.2942	20.8076	13.5032
$SOCDIF_{i,t}$	$MLEVDIF_{i,t}$	γ	-4.7663**	-5.9884***	-4.9886	3.4387	-7.5013**	-1.2683
			(1.9127)	(2.2348)	(5.2711)	(5.4930)	(3.4753)	(2.3187)
		Adj. R^2 (%)	27.3062	26.5094	35.8501	20.4097	26.0789	28.8008
	$BLEVDIF_{i,t}$	γ	0.1542	-0.9992	12.9828***	-13.2218**	-6.0537**	4.7222**
			(1.6902)	(1.9054)	(4.5651)	(6.4793)	(2.6844)	(2.1598)
		Adj. R^2 (%)	27.1712	26.3058	36.8895	21.1863	26.0745	28.9279
$GOVDIF_{i,t}$	$MLEVDIF_{i,t}$	γ	1.5498	1.2421	3.3751	5.7458	2.2344	2.1988
			(1.7597)	(1.9242)	(5.7212)	(6.5064)	(3.9044)	(1.9668)
		Adj. R^2 (%)	15.9999	14.9195	18.9115	19.4938	12.2327	19.9239
	$BLEVDIF_{i,t}$	γ	6.6502***	7.9230***	-2.8268	6.4451	7.3244**	6.1825***
			(1.8099)	(2.0951)	(4.8424)	(5.8753)	(3.1158)	(2.2001)
		Adj. R^2 (%)	16.2365	15.2719	18.8983	19.4976	12.4921	20.1214
.		Num. obs.	4416	3432	600	384	1776	2640

Note: Arellano standard errors in the parentheses, ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

We estimate similar coefficients for manufacturing firms, but the coefficient on the ESG score is significant only at the 10% level. Due to a one percentage point decrease in the deviation from the golden ratio-based book leverage target, the deviation of the ESG score decreases by 0.027 points, and the deviation of the governance pillar score decreases by 0.079 points. Service firms have positive coefficients in the ESG and social pillar score models. The trade sector has a positive coefficient in the market leverage model of the environmental pillar score. Upon examining the regional subsamples, we can observe that the book leverage model of the governance pillar score displays positive coefficients for the United States subsample. Additionally, in the European subsample, all book leverage coefficients are shown to be positive and statistically significant. We can argue again that the manufacturing firms drive our results in the case of the full sample.

In some cases, negative, statistically significant coefficients are observed, which suggest that firms do not apply golden ratio-based leverage targeting in the presence of better ESG performance. By examining the entire sample, we find a negative association between golden

ratio-based leverage targeting and social pillar performance in the case of the market leverage model. Manufacturing firms avoid golden ratio-based leverage targeting when they have better environmental and social pillar performance and better ESG performance overall. Trade sector firms display a negative relationship between golden ratio-based leverage targeting and social pillar performance in the case of the book leverage model. Negative coefficients are predominantly observed in the case of market leverage. Adeneye, Kammoun, and Ab Wahab (2022) suggest that negative coefficients can be observed due to the fact, that firms instead apply book leverage targets because of the potential misevaluation of the market value of equity.

Our findings show that firms choose to have a leverage closer to the golden ratio-based targets in those financial years when they have a better ESG performance. Choosing golden ratio-based leverage targeting is associated with better governance pillar performance in the manufacturing sector, better social pillar performance in the service sector, and better environmental pillar performance in the trade sector. The results also exhibit regional differences, as choosing golden ratio-based leverage targeting in the presence of better ESG performance is more typical for European listed firms than listed firms in the United States.

Table 8. presents an analysis of the relationship between the deviation of the actual ESG score from its highest value over a 12-year period and the deviation of the actual leverage from the golden ratio-based target leverage as per equations (3)-(10) across different regions and sectors. We find that European manufacturing firms may decide to apply a golden ratio-based book leverage target when they have a better ESG performance. This is supported by the presence of a positive and statistically significant coefficient for all environmental, social, and governance pillars, as well as ESG scores. A decrease in the deviation of book leverage from the golden ratio target by one percentage point results in a corresponding decrease in the deviation of the ESG score by 0.068 points, the deviation of the environmental pillar score by 0.073 points, the deviation of the social pillar score by 0.055 points, and the deviation of the governance pillar score by 0.069 points. Additionally, manufacturing firms in the United States may choose golden ratio-based leverage targeting when they have better governance pillar performance. For this reason, we can observe a positive association between choosing a golden ratio-based book leverage target and the presence of better governance pillar performance in the manufacturing sector.

Table 8.: Golden ratio-based leverage targeting and the ESG performance by region and sectors

Dependent variable	Independent variable	Coefficient	Europe (Manufacturing)	Europe (Services)	Europe (Trade)	USA (Manufacturing)	USA (Services)	USA (Trade)
$ESGDIF_{i,t}$	$MLEVDIF_{i,t}$	β	1.1151	-0.5147	-3.4586	-8.0117**	10.5404	26.7158***
			(2.0954)	(4.2170)	(4.7491)	(3.4152)	(8.5700)	(8.6673)
		Adj. R^2 (%)	31.3916	44.6057	19.7895	28.2505	35.5744	41.3468
	$BLEVDIF_{i,t}$	β	6.8043***	9.1208**	-8.2329	-1.9503	3.3499	6.6611
			(1.8767)	(3.7084)	(7.0918)	(2.7190)	(5.8338)	(8.2043)
		Adj. R^2 (%)	31.8488	45.7408	20.2041	27.9752	35.2119	35.6719
$ENVDIF_{i,t}$	$MLEVDIF_{i,t}$	β	-0.4100	12.0636**	0.9822	-1.9354	7.1295	52.6786***
			(2.9059)	(5.8265)	(6.5726)	(4.7748)	(12.4443)	(15.4244)
		Adj. R^2 (%)	13.6741	16.2070	3.9415	20.0062	19.2000	29.4057
	$BLEVDIF_{i,t}$	β	7.3402**	5.4614	-7.5146	-4.8470	-23.4468***	19.5128
			(2.8713)	(4.9875)	(9.2058)	(3.9225)	(8.8827)	(17.4023)
		Adj. R^2 (%)	14.0313	14.7879	4.2474	20.0891	20.8813	21.1619
$SOCDIF_{i,t}$	$MLEVDIF_{i,t}$	β	0.0661	-4.1911	-9.4324	-14.5656***	6.8783	27.6893**
			(2.7053)	(6.4172)	(6.0172)	(3.8718)	(9.2469)	(11.0553)
		Adj. R^2 (%)	27.9735	44.1103	17.4373	25.7173	27.1790	27.2377
	$BLEVDIF_{i,t}$	β	5.5294**	10.6800*	-12.5798	-9.3916***	13.3262*	-19.9066*
			(2.4211)	(5.5864)	(8.3047)	(3.0172))	(7.2905)	(11.3664)
		Adj. R^2 (%)	28.1618	44.8643	17.7212	25.4383	28.1444	23.4594
$GOVDIF_{i,t}$	$MLEVDIF_{i,t}$	β	2.9784	0.0897	0.7577	-0.6207	9.3052	17.6478
			(2.1572)	(6.8693)	(6.2463)	(4.2275)	(13.9264)	(14.5708)
		Adj. R^2 (%)	19.7703	17.0989	22.0891	10.0181	19.9215	16.1680
	$BLEVDIF_{i,t}$	β	6.8916***	2.4539	-1.7261	9.5762***	-9.7787	30.9789**
			(2.5043)	(6.3182)	(6.7320)	(3.6866)	(8.0005)	(13.0053)
		Adj. R^2 (%)	19.9988	17.1328	22.1030	10.4968	20.1514	17.8425
.		Num. obs.	2052	336	252	1380	264	132

Note: Arellano standard errors in the parentheses, ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Choosing a golden ratio-based book leverage target in the European service sector is positively related to social pillar performance. We can observe a similar pattern in the service sector of the United States. Within the trade sector, firms in the United States tend to choose a golden ratio-based market leverage target in the presence of better environmental and social pillar performance and ESG performance overall. In addition, manufacturing firms in the United States exhibit a negative association between golden ratio-based leverage targeting and social pillar performance in the case of market and book leverage models and with the ESG performance overall in the case of the market leverage model. In the case of service sector firms in the United States, a negative relationship between the golden ratio-based leverage targeting and environmental pillar performance is observed in the case of the book leverage model. Within the trade sector of the United States, golden ratio-based leverage targeting is negatively linked to social performance in the case of the book leverage model. Our findings further confirm that golden ratio-based leverage targeting is more typical for European listed firms.

Discussion

Our paper aimed to scrutinize whether golden ratio-based leverage targeting is linked to better ESG performance. To answer this research question, we examined the temporal dynamics of leverage in relation to the golden ratio-based leverage targets and explored the relationship between golden ratio-based leverage targeting and the ESG performance in a cross-sectional setting.

In the H1 hypothesis, we posit that firms actively adjust their leverage towards the important levels defined by the golden ratio. The H1a hypothesis considers the adjustment toward the market leverage target, while the H1b hypothesis deals with the adjustment toward the book leverage target. We find evidence alone in the manufacturing sector of Europe and the United States that firms apply golden ratio-based leverage targeting and actively adjust their market and book leverage towards the important levels defined by the golden ratio regardless of their geographical location. We argue that golden ratio-based leverage targeting is attributed to sector-specific characteristics, as the difference between the mean leverage and the golden ratio-based targets is insignificant in the manufacturing sector. In addition, we pointed out that golden ratio-based leverage targeting can be considered a heuristic managerial decision, which ties the leverage to crucial levels applied by other firms. As a summary of our findings, we can only partially reject our H1, H1a, and H1b hypotheses, as it turns out that golden ratio-based leverage targeting is a sector-specific characteristic for manufacturing firms.

In the H2 hypothesis, we stated that when firms have better ESG performance, they choose to have a leverage closer to the important levels defined by the golden ratio. The H2a hypothesis considers the association between golden ratio-based leverage targeting and ESG performance in the case of market leverage. In contrast, the H2b hypothesis posits that golden ratio-based leverage targeting is linked to better ESG performance in the case of book leverage.

Overall, the findings about golden ratio-based leverage targeting and ESG performance are presented comprehensively in Table 9. Upon examining the entire sample, we find evidence that firms choose to have a book leverage closer to the important levels defined by the golden ratio when they have better ESG performance. We argue that the results of the full sample are driven by the manufacturing sector since the manufacturing sector exhibits similar findings. Diving into our findings in more detail, we argue that manufacturing firms choose golden ratio-based book leverage targets in financial years when they have a better governance pillar performance, and service sector firms follow similar behavior when they have better social performance. On the other hand, trade sector firms choose a golden ratio-based market leverage

target in the financial years when they have better environmental pillar performance. Within the regional subsamples, we find that golden ratio-based leverage targeting is more typical in the case of European listed firms. As a summary of our findings, we cannot reject our H2b hypothesis since we find that golden ratio-based leverage targeting is predominantly linked to better ESG performance in the case of book leverage.

Table 9: Summary of the results

Sector	Region	ESG		ENV		SOCDIF		GOVDIF	
		MLEV	BLEV	MLEV	BLEV	MLEV	BLEV	MLEV	BLEV
All	All		+			–			+
	US				–	–	–		+
	Europe		+		+		+		+
Manufacturing	All	–	+	–		–			+
	US	–				–	–		+
	Europe		+		+		+		+
Service	All		+				+		
	US				–		+		
	Europe						+		
Trade	All			+			–		
	US	+		+		+	–		+
	Europe								

Our paper has three main theoretical contributions. First, our results align with the findings of Hovakimian, Opler, and Titman (2001), who pointed out that firms actively adjust their leverage towards the industry average. In this regard, we also posit that golden ratio-based leverage targeting is attributed to sector-specific characteristics since the mean leverage of the manufacturing sector does not differ from the golden ratio-based market and book leverage targets. We also agree with Frank and Goyal (2009), who stated that this behavior is attributed to discretionary managerial decisions.

Second, our results contradict the literature about ESG performance and capital structure. We argue that when firms have better ESG performance, they apply golden ratio-based leverage targeting instead of assessing the benefits of using more debt or equity, which ties their leverage to crucial levels other firms apply. Thus, golden ratio-based leverage targeting is linked to better ESG performance. Finding a positive, statistically significant relationship between golden ratio-based leverage targeting and the ESG performance in the manufacturing and service sector in a cross-sectional setting complements the theories of the optimal capital structure. On the other hand, golden ratio-based leverage targeting contradicts the findings of dynamic capital structure theories like Adeneye, Kammoun, and Ab Wahab (2022), which assume that target leverage changes constantly over time.

Third, we contribute to the literature on golden ratio-based capital structure as we examine whether golden ratio-based leverage targeting is linked to better ESG performance. Ulbert, Takács, Csapi (2022) and Amin and Cek (2023) showed that a golden ratio-based capital structure can boost financial performance and market acceptance. We contribute to that literature by showing that firms choose to have a leverage close to the golden ratio-based targets when they have a better ESG performance.

Conclusion and implications

As our paper scrutinizes the relationship between golden ratio-based leverage targeting and the ESG performance of listed firms in Europe and the United States, our findings can provide valuable insights from a practical point of view. Table 9. presents a comprehensive map of the capital structure decisions, taking into account the sectoral and regional attributes, the ESG performance, and the type of leverage. Previous research showed that it is not beneficial for firms to deviate from the capital structure of the competitors to a large extent. Thus, managers should choose a target leverage closer to the leverage of the competitors, which can contribute to market acceptance. Positive signs in Table 9 indicate that firms with certain attributes apply golden ratio-based leverage targeting, which can provide an anchor for managers to which they can relate when determining their target leverage as the basis of the weighted average cost of capital (WACC) calculations. We show that golden ratio-based leverage targeting is predominantly related to book leverage and sector-specific attributes. We find regional differences alone in the case if we consider the dimension of ESG performance. We consider golden ratio-based leverage targeting as a heuristic approach, which makes it easier for managers to follow competitors with similar market valuation, financial performance, and ESG performance.

Our research has limitations since we do not examine the direction of the causality upon examining the association between ESG performance and golden ratio-based leverage targeting. In addition, we do not consider control variables well known from the capital structure decisions to add more dimensions to our analysis. We only examine the stand-alone relationship between the absolute deviations. Last, we do not incorporate the previous research findings about golden ratio-based capital structure into our analysis as we do not consider the impact of market valuation and financial performance on the investigated relationship. Future research could fill this gap, as we would like to examine how market valuation, financial performance, ESG performance, and capital structure relate to each other and what we can tell about the direction of causality.

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