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SBFIN BID

QUALIS CAPES

A4 (MANAGEMENT)

A4 (ECONOMICS)

É com grande satisfação que apresento o prefácio da Edição Especial da RBFin - Revista Brasileira de Finanças - Vol. 21 nº 1 (2023), intitulada Prêmio BID-SBFin 1ª Edição: Financiamento e Desenvolvimento Sustentável. Este prêmio teve como objetivo principal incentivar a busca por soluções inovadoras para o desenvolvimento do mercado de capitais brasileiro e de instrumentos financeiros sustentáveis e inovadores.

O Brasil é a maior economia da região e possui um enorme potencial de crescimento em seu mercado de capitais. Nesse contexto, as sublinhas temáticas selecionadas para este prêmio são extremamente relevantes, pois buscam potencializar a recuperação sustentável da economia brasileira após a pandemia de Covid-19, por meio do desenvolvimento de instrumentos financeiros sustentáveis e inovadores.

Os artigos selecionados para esta edição especial da RBFin apresentam soluções inovadoras e práticas para alavancar as estruturas existentes hoje, explorar nichos específicos do mercado, como a CPR Verde, e desenvolver novos conceitos, como as securitizações via Sistema Nacional de Fomento em captações temáticas. Além disso, os artigos apresentam estratégias para potencializar a atuação das instituições financeiras do Sistema Nacional de Fomento, promovendo uma recuperação econômica sustentável e atraindo o capital privado.

Neste sentido, esta edição especial da RBFin é uma leitura fundamental para todos os interessados no desenvolvimento do mercado de capitais brasileiro e em soluções inovadoras para o financiamento e desenvolvimento sustentável. Parabenizo a todos os autores e agradeço aos organizadores do Prêmio BID-SBFin por proporcionarem a oportunidade de conhecermos essas ideias tão relevantes e inspiradoras.

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It is with great pleasure that I present the preface the Special Edition of the Brazilian Review of Finance (RBFin, Vol. 21, nº 1, 2023), entitled BID-SBFin Award 1st Edition: Financing and Sustainable Development. This award aimed to encourage the search for innovative solutions for the development of the Brazilian capital market of sustainable and innovative financial instruments.

Brazil is the largest economy in the region, with a capital market of enormous growth potential. In this context, the award theme is extremely relevant, as they seek to enhance the sustainable recovery of the Brazilian economy after the Covid-19 pandemic through the development of sustainable and innovative financial instruments.

The articles in this special RBFin edition offer innovative and practical solutions to leverage existing structures; explore specific market niches, such as the Green CPR; and develop new concepts, such as securitizations via thematic issuances by the National Development System. In addition, the articles present strategies to enhance the role the financial institutions tha comprise the National Development System, promoting sustainable economic recovery and attracting private capital.

Accordingly, this Special Edition of RBFin is a fundamental reading for all interested in the development of the Brazilian capital market and innovative solutions for financing and sustainable development. I congratulate all the authors and thank the organizers of the BID-SBFin Award for us whit the opportunity to learn about these relevant and inspiring ideas.

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The authentic Bee-Coin: A tokenized financial instrument for revenue-generating projects with social or environmental impact

Marcelo Guzella[†]
Geraldo Fernandes[‡]
Yumi Oki [*]

Abstract This paper proposes an innovative financial instrument to fund projects that combine profit-making with significant social or environmental goals, specially in emerging or low-income economies. The proposal is based on improvements to the typical impact bond model with the aim of better aligning the parties' incentives, and also making it more transparent, traceable and compatible with revenue-generating projects. It is applied to a pilot project to fund the establishment of a robust supply chain of green propolis in Minas Gerais, Brazil. Propolis is a natural product with benefits for human health, which has been consumed by humans for decades and raised substantial global interest after the Covid-19 pandemic. This project addresses some industry issues (in terms of product quality and supply stability) and aims to provide biodiversity recovery, subsistence farming and resocialization through work. A financial model with stochastic variables is simulated, incorporating a reward system based on the impact outcomes. The results confirm that the instrument improves risk-return trade-off and advocate for its use in projects with sustainability objectives.

Keywords: Impact bonds; Green propolis; Sustainable finance; Resocialization; Biodiversity; Subsistence farming; Tokenization.
JEL Code: Q01, O13, O16, Q57.

1. Introduction

Impact bonds are contracts based on outcomes, in which private funding from investors is used to cover the upfront capital required for a provider to deliver a social or environmental service (Agusti Strid et al., 2021). If predicted outcomes are achieved, a bond guarantor (typically a government entity or a philanthropic or multilateral organization) repays the investor's capital. Impact bonds have gained prominence and been increasingly adopted in

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[†]EBAPE / Fundação Getúlio Vargas and Companhia de Desenvolvimento de Minas Gerais, Brazil: marcelo.guzella@fgv.br
[‡]Universidade Federal de Minas Gerais, Brazil: gwilson@icb.ufmg.br
[*]Universidade Federal de Minas Gerais, Brazil: yumioki@ufmg.br

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several countries. However, some limitations hinder its adoption, such as possible misalignment of incentives and undesirable risk-return profile (Saenz, 2022). Moreover, the projects that are funded typically do not generate revenue, at least not enough to cover the costs to achieve the social or environmental outcomes. This paper describes a financial instrument to fund revenue-generating projects with features adapted from the impact bonds framework. It also presents the financial implications of the use of this instrument in a real case that involves beekeeping and vegetation cover restoration in the Brazilian cerrado (savanna) biome.

Pay for success mechanisms are used to foster structural changes in how social policies or environmental projects are developed. Enthusiasts of impact bonds highlight that they increase the focus of public policies on results, shifting the orientation from activities to outcomes. Studies show that these instruments can overcome perennial government challenges, such as the fragmentation of public services, a short-term political and financial focus and lack of collaboration and innovation (Agusti Strid et al., 2021; Dowling, 2017). Azemati et al. (2013) point that impact bonds help overcome barriers such as political constraints that prevents governments from investing in prevention, inability of non-profits to access capital and limited capacity to raise evidence about what works.

According to Carter et al. (2018), while traditional service deliver results in siloed budgets or redundant assignments, impact bonds focus on mutually dependent or aligned outcomes, which determine payment and hence foster the coordination of a variety of commissioners across different units and levels of government. Moreover, resources are traditionally directed to crisis-point situations and costly remedial services, resulting in short-term orientation and reactive services. Social impact bonds (SIBs), on the other hand, are based on invest-to-save and upstream interventions, funding preventative measures that decrease the need on further remedial services when the outcomes are achieved. SIBs also foster innovation, in terms of performance management and choice of intervention or provider, by transferring financial risk from commissioners and service providers to investors.

While potentially beneficial, impact bonds can be complex and expensive to design and require reliable data and stable regulatory environment (Acevedo and Live, 2016). Agusti Strid et al. (2021) point that the high complexity and costs arise from the need to bring together several different participants with distinct incentives and that may not be familiar with the technical aspects of the arrangement, such as results measurement and pricing of outcomes. Moreover, they require a high level of commitment and capacity but, at the same time, the amount involved in the contract may not be large enough

to break even those costs or to arouse market interest. Since performance defines payments, its evaluation requires a robust and rigorous methodology and available data, with treatment and control samples, to be reliable. Stable political and economic environment is also determinant, since SIBs take time to design and implement, therefore institutional or macroeconomic turmoil affect SIB continuity and the willingness to pay for outcomes.

Impact projects in developing economies, even the ones that are expected to generate revenue, typically have challenges that limit the access to capital from private investors, specially in moments of higher risk aversion (Bartzokas, 2022). Political and institutional instability, inflation, liquidity, currency or technological risk, lack of skilled labor or of law enforcement affect investment inflows (Asiedu, 2006). Even with higher expected returns and positive sustainability impact, projects in developing economies typically struggle to access capital from private investors worldwide (Diamonte et al., 1996). Risk-averse investors are reluctant to invest in bold projects and prefer allocate in highest-income countries and/or in low yield fixed-income assets (Bartzokas, 2022; Schlumpf, 2017).

Financial innovations have a key role in the development of instruments to make those opportunities more attractive or more compatible with investors expectations or preferences. There is also positive feedback, since the availability of capital and the development of financial markets decisively influence the way in which new technologies are created and projects are structured. Considering this context, we propose the creation of a mechanism similar to impact bonds to revenue-generating projects with relevant impact potential in developing economies. The goal is to improve the risk and return trade-off of those projects to investors, in a way that they can profit from operational performance as well as from the achievement of social or environmental impact. The reward for impact, granted by the outcome payer (or a bond guarantor), benefits not only financial investors, but other relevant stakeholders that commit upfront capital to the project (land owners and large customers) or that provide services to the project (beekeepers and farmers). This aligns incentives and improves the liquidity of the security that represents the ownership of these impact award rights.

This paper addresses the problem of lack of capital to projects that combine profitability with sustainable outcomes in developing economies. It attempts to answer whether an adapted structure of impact bonds can be useful to funding those initiatives and better aligning stakeholders' incentives. It adds to the field by proposing an innovative financial instrument to increase private funding likelihood of projects in developing countries. Such instruments aim at the development of the capital markets and the global financial

system by providing new means for encouraging private funding for impact investing, leading to a more sustainable economy and ultimately mitigating harmful effects of climate change. It also contributes to a more socially responsible society, since the proposal covers aspects such as inclusion and employability. This security is in line with other less granular innovations such as the green and sustainable bonds, a market that has already reached more than one trillion dollars (Sartzetakis, 2021), despite a still low presence in Latin America or emerging economies in general.

This study relates to the strand of the literature about financial innovations aimed at preserving the environment or improving social welfare (Bhutta et al., 2022; Maltais and Nykvist, 2020). They contribute to aligning the objectives of firms and economies towards a more sustainable growth path (AlAhbabi and Nobanee, 2020; Park, 2019). Such innovations help close the spending gap of approximately USD 1 trillion annually, in low- and middle-income countries, necessary to achieve the 17 Sustainable Development Goals defined by world leaders (Anderson et al., 2022; Colglazier, 2015; Kharas and McArthur, 2019).

Some innovative mechanisms have been developed and applied to contribute to higher capital allocation in projects oriented to sustainability goals. Besides green and sustainability bonds, impact bonds are an interesting instrument to provide more effectiveness to public policies. The Rhino Bond is an impact bond (specifically a wildlife conservation bond) with the goal to protect and increase black rhino populations in South Africa (Endsor et al., 2020). Social impact bonds are also very common in projects to improve public education or health outcomes (Fraser et al., 2018).

Despite relative complexity and higher structuring costs, impact bonds are a promising instrument, but some shortcomings limit their usage. The first one is that, in the classical model, investors carry all the execution risk (Liang et al., 2014). This means that the service provider payment is usually not sensitive to its performance, which may create a conflict of interest. The instrument we propose overcomes this limitation by allowing the risk to be shared between capital and service providers. Moreover, impact bond models often determine payments without considering the revenue that the project may generate (Jackson, 2013). This occurs because they are usually applied to public policies such as social services for vulnerable population or environmental conservation. The proposed model is an improvement on impact bonds as it has a mechanism that combines socio-environmental outcomes with financial results.

Some recent technological features can also have a significant role in boosting financial innovations. The most prominent one is the blockchain,

which basically uses cryptography and a peer-to-peer computer network to securely link together the transaction records (Zheng et al., 2018). Blockchain has allowed the release of interesting digital securities, such as tokens or smart contracts, with the potential benefits of more transparency and lower regulatory and intermediation costs (Belotti et al., 2019). After created, tokens can be used for the consumption of the issuer's goods or services or to represent fractions of the ownership of the company, representing future profits.

The literature on tokens offerings is growing significantly. Studies have been reporting the release of digital tokens with a wide range of applications, from gaming to biodiversity conservation (Arora et al., 2022; Oberhauser, 2019). Chod and Lyandres (2021) point that utility token financing mitigates entrepreneurial effort underprovision but increases underproduction risk. They show that token financing signals venture quality to investors and is more suitable when production costs are low, entrepreneurial effort is crucial and payoff volatility is low. Gan et al. (2021) emphasize that tokens better align incentives but show that, depending on margins and demand characteristics, coin offerings can lead to relevant agency costs, underproduction and loss of value in unregulated environments. The model we propose in this paper includes the issuance of marketable tokens to define the performance measurement and payment rules in a more transparent and traceable way. Due to its application in a beekeeping pilot project, we name it Bee-coin.

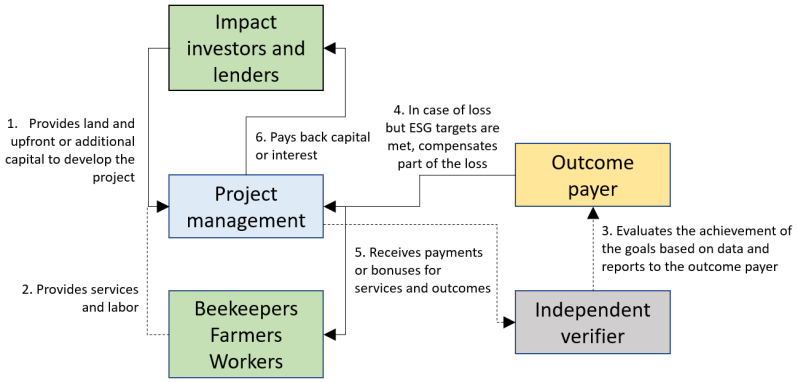
The structure of this document is as follows: in the next section we describe the instrument in general terms, comparing it with other funding alternatives. After that, we apply it to the real case (Project *Baccharis*) and present relevant model parameters and assumptions. Finally, we present the results of the simulation that combines the project operational and impact performance. Finally, we analyse the results and make final considerations.

2. Financial structure

Figure 1 describes the framework that relates the project execution and investment with the impact bond designed to compensate possible losses when ESG targets are met. Investors may include senior lenders, subordinate lenders and grant makers. The independent verification can be done by evaluators and validators. For simplification, the framework omits some typical roles such as intermediaries, lawyers and technical assistance providers.

When the project is released, production and sustainability goals are defined for the current year. One or more outcome payers are also identified. When investors and lenders provide upfront capital for the project, they receive tokens issued by the firm. Workers and service providers also receive tokens as they develop the work necessary for production and sustainability

Figure 1
Project investment, payment, implementation and verification structure



Note: Model describing the steps and relationships between project stakeholders.

goals.

When the year ends, an independent verifier check whether sustainability goals were achieved. If the project recorded a financial loss over that year (compared to a benchmark) but achieved the predefined sustainability goals, the outcome payer compensates part of the loss. The project management receives this compensation from the outcome payer and transfers part of it to workers. The compensation also reduces the additional capital from investors and lenders necessary to resume operations.

On the other hand, if the project records a net profit but does not achieve the sustainability targets, it compensates the outcome payer, transferring part of the profit that could have been used as dividends or bonuses. Hence, different from classical SIBs, part of the risk is shared by service providers and outcome payers are compensated when ESG targets are not achieved.

Table 1 presents a comparison between Bee-coin and extant funding alternatives for early-stage projects. Assuming that in typical startups the service provider is the entrepreneur itself, in all alternatives but SIBs he/she shares the risks of the project. Traditional funding instruments (banks and venture capital) are heavily regulated and typically lead to control rights. In crowdfunding alternatives, retail consumers and speculators are the ones who fund the project. Digital coin offerings also have risk sharing but also allow secondary trading. Equity alternatives (both in crowdfunding and coin offerings) have higher regulation and risk sharing. Bee-coin combines the sensitivity to sustainability outcomes, typical of impact bonds, with features of equity

offerings.

Table 1
Comparison of financial instruments for early-stage projects

			Crowdfunding		Coin offering		Impact bonds	
Financing method	Bank	VC	Reward	Equity	Utility	Equity	SIBs	Bee-coin
Upside through profit sharing	✗	✓	✗	✓	✗	✓	✗	✓
Upside through revenue sharing	✗	✗	✗	✗	✓	✗	✗	✗
Downside demand risk sharing	✓	✓	✗	✓	✓	✓	✗	✓
Heavily regulated	✓	✓	✗	✓	✗	✓✗	✓	✓✗
Voting/control rights	✓✗	✓	✗	✗	✗	✓✗	✗	✓✗
Funds from retail speculators	✗	✗	✗	✓	✓	✓	✗	✓
Funds from retail consumers	✗	✗	✓	✓	✓	✓	✗	✓
Secondary trading	✗	✗	✗	✗	✓	✓	✗	✓
Sensitivity to ESG outcomes	✗	✗	✗	✗	✗	✗	✓	✓
Risk shared by service provider	✓	✓	✓	✓	✓	✓	✗	✓

Note: A checkmark indicates that the feature is characteristic of the instrument, while an ex indicates that it is nonexistent or secondary. Dual notation indicates that the feature is sometimes present. VC means Venture Capital. Adapted from Gan et al. (2021).

Equation 1 describes the cash flow to investors in terms of the cash flow generated by the project ($\mathrm{FCF}_{\mathrm{project}}$) and the reward or penalties associated with the sustainability impact. For simplicity, only equity is considered, although debt funding can be used as well.

$$\begin{aligned}\mathrm{PV}(\mathrm{FCF}_{\mathrm{total}}) = {} & \mathrm{PV}(\mathrm{FCF}_{\mathrm{project}}) \\ & + \mathrm{PV}(\mathrm{ID}_{\mathrm{profit}<P1} \times \mathrm{ID}_{\mathrm{impact}>R2} \times \mathrm{Rate} \times \mathrm{FCF}_{\mathrm{project}}) \\ & - \mathrm{PV}(\mathrm{ID}_{\mathrm{profit}>P2} \times \mathrm{ID}_{\mathrm{impact}<R1} \times \mathrm{Rate} \times \mathrm{FCF}_{\mathrm{project}})\end{aligned} \tag{1}$$

The main goal is to reduce the variance of the cash flows using the reward system. Hence, whenever the profit is above certain threshold, part of it is offset whether the sustainability targets are not reached. On the other hand, when the profit is below another certain threshold, it can be compensated by the reward system in case those sustainability targets are reached. The model variables define this rational: $\mathrm{ID}_{\mathrm{profit}<P1}$ is an indicator variable that is equal to 1 when the profit is below the threshold $P1$; $\mathrm{ID}_{\mathrm{profit}>P2}$ is an indicator variable that is equal to 1 when the profit is above the threshold $P2$; $\mathrm{ID}_{\mathrm{impact}<R1}$ is equal to 1 when the index that consolidates the impact targets is below $R1$; finally, $\mathrm{ID}_{\mathrm{impact}>R2}$ is equal to 1 when the index that consolidates the impact targets is above $R2$.

3. Project *Baccharis*

Baccharis dracunculifolia (alecrim-do-campo) is a native plant in Brazil with a key role in the propolis production. The honeybee collects resin from

the main budding buds of alecrim-do-campo and uses it to produce propolis in the hive (Righi et al., 2011; Zabaiou et al., 2017). Propolis, particularly the Green Propolis, not only helps to protect the hive but also has several benefits for human health (antibacterial, antifungal, anti-inflammatory, antitumor and immunostimulating properties, among others) due to its complex composition, making it a highly attractive product (Bankova et al., 2000; Chan et al., 2013; Oliveira et al., 2021; Silva-Beltrán et al., 2022). Alecrim-do-campo, in turn, can be used to recover areas of degraded vegetation, which benefits local biodiversity (Fernandes et al., 2016).

Brazil, and particularly the state of Minas Gerais, produces and exports a relevant volume of propolis, having a prominent global position (Ramos Junior, 2017). Despite some seasonal instability, producing propolis is potentially profitable (Mountford-McAuley et al., 2021). After the pandemic, prices in the international market increased substantially, with Japan being an important consumer (Oliveira et al., 2021). However, this Brazilian industry still has a high level of informality in the upstream and concentration of few players in the downstream (Wilkinson et al., 2017). Furthermore, there is significant room for research and development initiatives, limited reliability in terms of quality and sustainability impacts are far from being measured or targeted (Ramos Junior, 2017).

In order to tackle these issues, the Project *Baccharis* aims to develop a robust supply chain of Green Propolis in Minas Gerais. It is a partnership between researchers from the Federal University of Minas Gerais (UFMG), the Development Company of the same state (Codemge, state-owned), among others institutions. The project funding, or a relevant part of it, can be done through impact bonds due to the social and environmental results it potentially generates.

The project encompasses a facility that produces propolis extract units using raw propolis supplied by a network of individual beekeppers. After receiving the seedlings, they are responsible for the cultivation, the maintenance of the hives and the extraction or raw propolis, with technical support from the project management. Beekeeping does not require large land, time or high start-up costs (if performed in a decentralized medium-sized scale) and can be developed not only by subsistence farmers in rural communities but also from inmates or ex-inmates in a government program of resocialization.

The project contributes to mitigating the level of informality and low predictability of supply in the sector. With the creation of a robust supply network, designed by researchers with extensive experience and knowledge in this industry, propolis production becomes more stable and presents better quality assurance.

Table 2 presents some operational projections for the project, considering an average production volume of 150 thousand bottles per month. Raw propolis is estimated considering that bottles have 30mL and 18% concentration. Moreover, each beekeeper should produce around 15kg of propolis per month with 25 hives. This number of hives corresponds to two thousand seedlings and 20 hectares. Figure 2 shows the break-even point at around 75 thousand bottles per month. It reduces to 50 thousand bottles if gross margin is 5% higher than expected, but increases to 150 thousand bottles if gross margin is 5% lower.

Table 2
Monthly operational figures of the project

	2024	2025	2026	2027	2028	2029	2030	2031	2032
Seedlings (k)	167	333	500	500	500	500	500	500	500
Cultivation area (ha)	1,667	3,334	5,000	5,000	5,000	5,000	5,000	5,000	5,000
Hives	2,084	4,167	6,251	6,251	6,251	6,251	6,251	6,251	6,251
Beekeepers	83	167	250	250	250	250	250	250	250
Raw propolis (kg)	1,250	2,500	3,750	3,750	3,750	3,750	3,750	3,750	3,750

Note: Expected values of the main operational indicators of the project. After Alecrim-do-campo is cultivated with supplied seedlings, bees collect resins from it in the pollen baskets on their hind legs and carry them back to the hive to produce raw propolis, which is extracted by beekeepers.

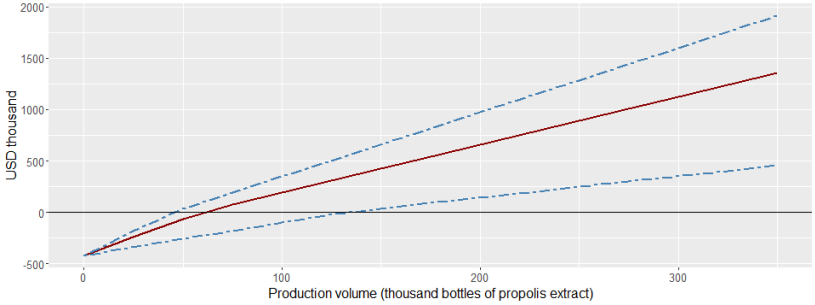
Besides the production facility managers, the beekeepers and the outcome payer, the project structure includes customers, landowners and investors as most relevant stakeholders. They can provide the upfront capital or the assets to implement the project and obtain returns according to the operational performance and the achievement of sustainability objectives. The tokenized impact bond is then a blockchain solution codified with rules that condition the earnings also to the achievement of pre-defined impact goals. Using blockchain technology to divide the project ownership into tokens can be beneficial in terms of decentralization, traceability and transparency.[1]

The focus of this work is not on the technical specificities of the blockchain solution to be adopted, nor the operational details of the project and product,[2] but to present a simulation of the results of this financial instrument after defining the most critical inputs.

[1] It is important to mention, however, that the proposition do not necessarily require the adoption of blockchain as a mechanism for dividing the project ownership and recording the related transactions. Competitive technologies could be adopted to regulate the relationship between the main stakeholders.

[2] These details can be found in other project documents, such as Fernandes et al. (2022).

Figure 2
Financial performance of the project as a function of monthly volume and gross margin



Note: Long-term annual free cash flow for different values of production output, in USD thousand. Dashed lines correspond to plus and less 5% of gross margin, with respect to the expected value.

4. Model parameters

Table 3 shows the current and average project projections, in real value. This level of consolidation preserves some strategic aspects of the business plan. For this current version, we considered some premises that simplify the business model. Firstly, all the raw propolis is supposed to be supplied by independent beekeepers. This is most likely to occur but own production can complement the supply and does not materially affect the analysis. Decentralized and outsourced production justifies the relevance of a financial instrument that can better align incentives and promote compensation for sustainability goals.

Besides that, projections are conservative in the sense that average prices are in line with domestic Brazilian prices. This means that the option to export part of the production is a relevant upside for the project results. Moreover, the main product adopted is the 30mL bottle of green propolis extract with a concentration of 18%. Other products can complement the portfolio and also improve the project financials. The assumptions that defined the projections were obtained through research with the project's technical team, secondary information collected on the internet and other specialists. The simplification of the business model eases the analysis of simulated effects of the financial instrument. Improvements do not materially affect the analysis of the contributions of the financial instrument, but can affect the calibration of the compensation system.

The output of the simulation is the internal rate of return and the present value of the project free cash flow, considering a cost of capital of 15% and no

Table 3
P&L Statement of the Project (in USD thousand)

	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Net revenue		**2,016**	**4,032**	**6,048**	**6,048**	**6,048**	**6,048**	**6,048**	**6,048**	**6,048**
Cost of goods sold		**(1,845)**	**(3,468)**	**(5,092)**	**(5,092)**	**(5,092)**	**(5,092)**	**(5,092)**	**(5,092)**	**(5,092)**
Seedlings		(72)	(72)	(72)	(72)	(72)	(72)	(72)	(72)	(72)
Gross propolis		(1,350)	(2,700)	(4,050)	(4,050)	(4,050)	(4,050)	(4,050)	(4,050)	(4,050)
Consumables		(274)	(548)	(822)	(822)	(822)	(822)	(822)	(822)	(822)
Labor		(149)	(149)	(149)	(149)	(149)	(149)	(149)	(149)	(149)
Expenses		**(371)**	**(482)**	**(617)**	**(617)**	**(617)**	**(617)**	**(617)**	**(617)**	**(617)**
SG&A		(159)	(235)	(315)	(315)	(315)	(315)	(315)	(315)	(315)
R&D		(156)	(156)	(78)	(78)	(78)	(78)	(78)	(78)	(78)
Depreciation		(56)	(56)	(56)	(56)	(56)	(56)	(56)	(56)	(56)
Income taxes		(35)	(168)	(168)	(168)	(168)	(168)	(168)	(168)	(168)
Net income		**(200)**	**82**	**339**	**339**	**339**	**339**	**339**	**339**	**339**
Main equipment	(227)									
Infrastructure	(335)									
Working capital	(260)	(40)	(40)							
Sustaining	(17)	(17)	(17)	(17)	(17)	(17)	(17)	(17)	(17)	(17)
Free cash flow	**(839)**	**(201)**	**81**	**378**	**378**	**378**	**378**	**378**	**378**	**378**

Note: Annual expected values of the main financial indicators of the project. Revenue, net of indirect taxes, is obtained through sales of bottles of propolis extract to customers. The model encompasses the production and supply of seedlings, and the purchase of raw propolis thereafter. Raw propolis is then used with other consumables to manufacture propolis extract in the production facility. SG&A expenses include marketing, logistics, commercial and administrative costs. R&D expenses include consumables and labor to develop new products or improve the quality of current ones. Figures within parentheses are negative.

real growth after the horizon of the projection. As explained in Section 2, the payments related to three of the main stakeholders of the project (investors, landowners and large customers) are adjusted according to the achievement of social and environmental targets. When those targets are achieved, beekeepers and the plant management receive a reward through the surplus of such payments, limited to the cash balance. If, on average, more than 100% of the targets are achieved, they receive a 15% bonus; if they reach between 80% and 100%, a 10% bonus is due. Otherwise, investors, landowners and large customers get the surplus back.

Four types of social and environmental achievements are considered: number of subsistence farmers or beekeepers, recovered vegetation area, number of honeybees and number of workers hired in the context of the resocialization program. Table 4 presents the rational, benefits and targets for each objective. Those goals are considered the most relevant and, also important, they do not correlate substantially with the project financial or operational performance. Equal weights and linear relationships were considered for the reward system. This is a realistic assumption since all targets are meaningful and the linearity is plausible in the range of each indicator. Although some objectives can be verified in a higher frequency, reward verifications are planned to be done yearly.

Table 4
Sustainability objectives included in the system

Objective	Rational	Benefits	Target
(1) Percentage of raw propolis supplied by subsistence farmers or beekeepers	A relevant part of the propolis should be produced by a disperse network of farmers and beekeepers in rural communities	Employment and income generation in rural or disadvantaged areas, as well for minority groups	50% of the total required volume
(2) Recovered vegetation area (ha)	Cultivation activities should be also applied in areas with degraded vegetation	Recovery of part of the biodiversity, improved erosion control, lower levels of soil contamination, improved diversity of native species	4,167 (half of the total required area)
(3) Number of hives	Beekeeping activities maintain or increase the population of honeybees in some areas, which is good provided it does not harm native pollinators	Improved pollination services, increasing crop yields and agriculture productivity. Biernath (2022) mentions that hives near soybean plantations increase the production of this grain by 12 to 15%.	10,418 hives (necessary for planned capacity)
(4) Percentage of workers/beekeepers who are part of the resocialization program	Part of the cultivation, beekeeping and manufacturing activities should be performed by inmates or ex-inmates	Resocialization and rehabilitation, improving support and reducing reoffending	20% of the headcount

Those goals and sales volume were considered as probabilistic values. We considered triangular distributions due to its better compatibility with the nature of the project variables. Table 5 presents minimum, most likely and maximum values considered in the simulations, obtained after discussions with the technical team. It is important to mention that a capacity expansion is also a project upside for the future, in case expected demand is confirmed.

Table 5
Distribution parameters of the stochastic variables considered in the simulation

	Minimum	Most likely	Maximum
Monthly sales volume of bottles of propolis extract (thousand)	150	250	350
Percentage of raw propolis supplied by subsistence farmers or beekeepers	10%	50%	70%
Recovered vegetation area (ha)	2,500	4,167	5,834
Number of hives	6,251	10,418	14,585
Percentage of workers and beekeepers who are part of the resocialization program	0%	20%	30%

In terms of the additional cost that the project would have to incur to develop the sustainability goals, this analysis treats it as negligible. Partnerships with subsistence farmers and beekeepers are not costlier than those with other farmers. Moreover, according to the technical specialists, recovering vegetation is a natural effect of *Baccharis* cultivation. The number of hives is consequential of the production of raw propolis. Labor costs of workers from the resocialization program are about the same as costs of regular workers (TJDFT, 2022). Part of the administrative expenses should cover the coordination of this reward system, including measurement, target definition, monitoring and audit processes as well as partnership management.

The cash flow to investors, as a result of the flow generated by the project and the reward or penalties associated with the sustainability impact, was described in equation 1. The compensation or penalties based on the sustainability outcomes are due to any token holder.

The equation variables were calibrated for the simulation: the threshold $P1$ was set to 10% of the project initial committed capital and $P2$ to 30%. The references $R1$ and $R2$ were set to 80% and 100% of the pre-defined targets, with equal weights for them. The percentage considered for the reward and penalty was set to 30%. This calibration should be adapted to each project, with the goal of improving risk-return trade-off for investors without being an excessive burden to the bond guarantor.

5. Simulation results and analysis

Figure 3 presents the frequency distribution of the simulation results with 1,000 iterations, in scenarios with and without the impact reward system. Both the internal rate of return and the present value of the free cash flow are presented. It is possible to see that the reward system reduces the frequency of lower rates and present values, with more frequent results around the median. This means that the proposed financial instrument indeed reduces the project risk and improves risk-adjusted returns.

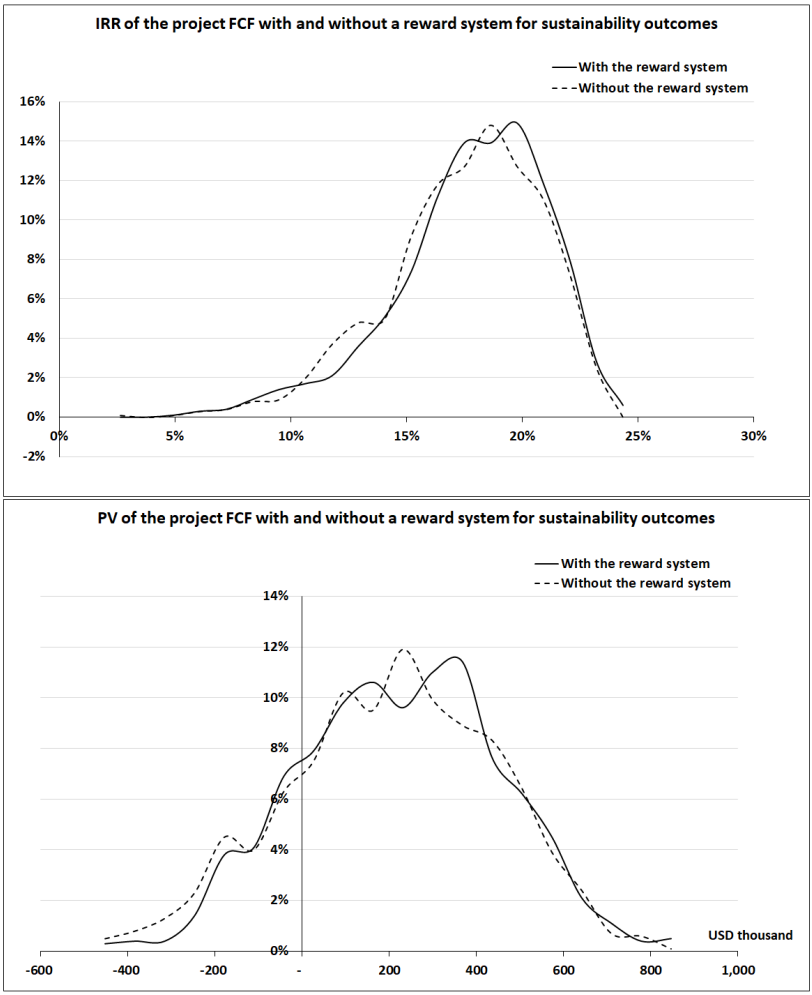
The distribution of rates of return and net present value without the reward system has averages of 17.47% and USD 1,020 thousand, respectively. With the reward system, the values improve to 17.80% and USD 1,119 thousand. More importantly, the standard deviations of those same variables reduce from 3.37% and USD 1,212 thousand to 3.34% and USD 1,158 thousand. Sharpe ratios went from 5.19 to 5.34.

Some observations can be derived by the effect of the reward system. First of all, it does not change dramatically the financial outcomes of the project, which means it would not be unattractive for the bond guarantor. Second, it does contribute as an additional incentive for managers and investors to achieve the sustainability targets. Even considering the uncertainty related to the achievement of the sustainability outcomes, the system reduced the percentage of cases with project negative present value from 20% to 18%. It is worth mentioning that the parameters can be adjusted to consider preferences and expectations of both investors and outcome payers.

6. Final considerations

In this analysis, we propose a funding instrument to contribute to the development of for-profit projects with relevant impact in developing countries.

Figure 3
Frequency distribution of the FCF and IRR of the Project, with and without the reward system



Note: Simulation results of the project financial performance with and without the compensations based on ESG outcomes.

The instrument is based on impact bonds, which are outcome-based contracts typically applied to public policies, with some improvements to be adapted to projects that are economically self-sustainable but may have a risk-return trade-off that is not compatible with certain private investors preferences. It considers the use of digital tokens to regulate the ownership and transactions and it works similarly to an insurance security, or to a derivative aiming to improve risk-adjusted returns and, at the same time, encourage the achievement of sustainability impact.

In order to investigate how this instrument affects a real case, we performed a simulation of the financial outcomes of a pilot project with relevant sustainable dimensions. The project aims to develop a production chain of green propolis in Minas Gerais, with a decentralized network to produce raw material and a central facility to develop R&D initiatives and to produce the extract to be sold.

Not all the features of the instrument need to be considered in a first place. Some aspects may still be better understood in future studies, such as the capital cost and possible methods for measuring each impact and the correlation between them and operational variables. Scale-up implications also deserve further refinements. Portfolio securitization may result in diversification gains that are not treated in our model as well.

The instrument proposed in this paper can be applied in other projects that generate revenue and social or environmental impact. However, some of the simplification assumptions made here may have to be adapted to the case, such as the equity-only funding.

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The generalized sustainability credit rating system

Rodrigo Zeidan[†]
Seye Onabolu[‡]

Abstract This article describes the steps required to generalize a sustainability credit rating system based on the analytical hierarchy process. We argue that such systems are ideal for commercial banks to improve their lending processes. Starting with the model by Zeidan et al. (2015), we transform the SCSS from a closed to an open platform by adding country and industry variables, two additional possible answers, and an explicit way to generate forward default probabilities. Finally, we present a model for final reports that could be used for banks that use this or similar credit systems. The final reports are generated after initial tests on a database of 100+ public companies, with over 1,000+ Monte Carlo simulations conducted in six months following the initial assessments.

Keywords: Green banking; Credit rating systems; Analytical hierarchy process; Commercial banks; Sustainability credit score systems.
JEL Code: G24, Q01.

1. Introduction

According to Edmans (2022), ESG (Environmental, Social and Governance) is extremely important and nothing special because it's no better or worse than other intangible assets. That includes those that drive long-term value and create positive externalities for broader society, such as management quality, corporate culture, and innovative capability. Yet that does not mean markets efficiently incorporate this type of information. In fact, some funds seem to be building an "anti-ESG" movement, assuming that tackling climate change is a job for public officials (Mundy and Bryan, 2022). Here, we follow Edmans (2022) in the idea that ESG indicators are relevant and unremarkable and consider augmented credit rating systems that better incorporate intangible assets, of which many are ESG indicators.

Our goal is to provide an open platform general sustainability-related credit rating system. Previous attempts (e.g., Zeidan et al., 2015) have been closed platforms created for specific consumers, such as commercial banks. We provide the detailed methodology for an open platform sustainability

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[†]NYU Shanghai, China: Rodrigo.zeidan@nyu.edu
[‡]Sona Circle, United Kingdom: seye.onabolu@sonacap.com

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credit-score system to facilitate financial institutions' abilities to overcome organizational inertia.

The inclusion of environmental and social elements in lending decisions has been advocated for and examined in the scientific literature for more than 20 years (e.g., Case, 1999; Cowton and Thompson, 2000; Acharya and Abuyuan, 2002). But there is currently no accepted technique for it. There are several causes for this (e.g., Rezaee and Tuo, 2019; Busco et al., 2020; Zeidan, 2022b), including the lack of agreement on which environmental issues should be taken into account by credit rating systems, the failure of any one method to outperform others, and the absence of established international regulatory requirements.

We argue that sustainability credit score systems that generate similar ratings to regular credit rating models are ideal for commercial banks to improve their lending processes. Imperatively, such systems must include upside and not only downside possibilities for the interaction between environmental and social drivers and financial performance. In addition, these systems must be able to generate ratings for companies of all sizes, not relying solely on publicly-available data. For that purpose, we provide a detailed methodology for a sustainability credit rating open platform based on analytical hierarchy processes. We generalize the closed-platform system in Zeidan et al. (2015) by, among other things, adding country and industry variables, two additional possible answers, and an explicit way to generate forward default probabilities. We also detail the final reports that could be used independently or alongside regular credit rating reports.

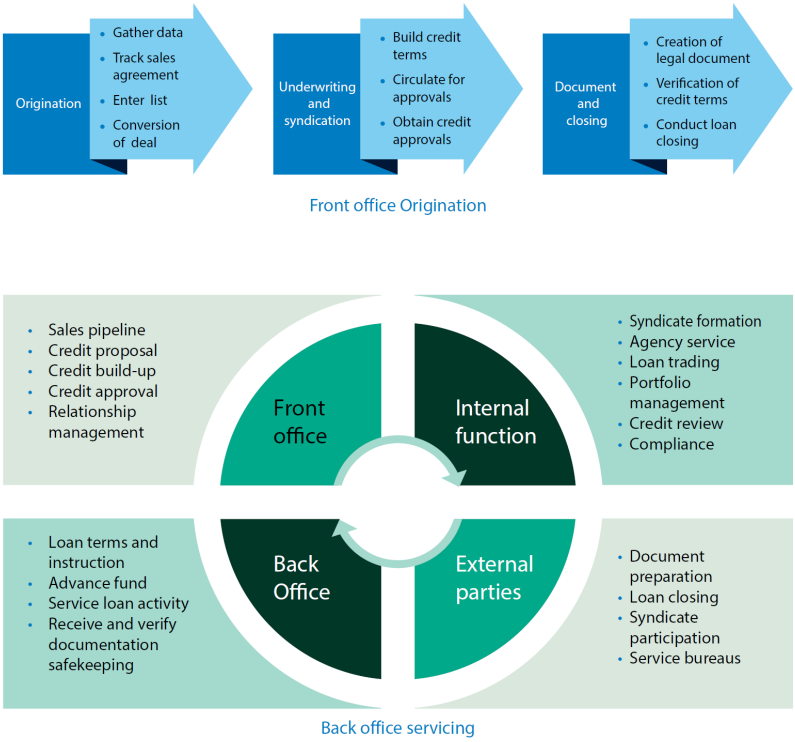
The following section discusses the reasoning for a stand-alone sustainability-related score rating system. The third section describes the methodological steps to generalize the SCSS. Finally, the last section concludes.

2. Why a general sustainability-related score rating system?

Our interest is in improving banks' lending decisions. In particular, the focus is on the process that involves evaluating prospective customers' likelihood of repaying loans in full (other stages include finding customers, assessing collaterals, designing loan agreements, and monitoring compliance). Figure 1 describes straight-through commercial banking lending processes.

Integrating climate and social risks in credit decision-making involves changing all steps of the lending process: origination, servicing, and asset management. In the present text, we are primarily concerned with credit risk assessment for lending origination. Specifically, by incorporating environmental and social factors into the gathering data step, banks could improve

Figure 1
Front office and back office straight-through lending processes



Sources: Kidder (2004) and Alexandar (2018).

their credit decisions, making them fairer (especially for external stakeholders), more robust, and consistent.

The literature has called for and analyzed the possibility of incorporating environmental and social factors into lending decisions for over twenty years (e.g., Case, 1999; Cowton and Thompson, 2000; Acharya and Abuyuan, 2002). However, we still don't have a standard method for it. There are a few reasons for it: there is no consensus on which environmental factors should be included in credit rating systems, no single method has outcompeted others, and no global regulatory mandates have emerged, among others.

A few robust initiatives come close to standardizing social and environmental factors in risk management models.

For instance, the Equator Principles[1] (EP) aim to serve as a common baseline for financial institutions to identify, assess and manage environmental and social risks when financing projects. However, the Equator Principles (now in its fourth version) deal with a narrow subset of commercial operations. It only applies to large infrastructure and industrial projects with capital costs of U$10 million and total aggregate loans of at least U$50 million.

ESG and reputation risk ratings encompass relative rankings of companies regarding environmental, social, and governance risks. Services like Sustainalytics[2] and Sustainable Fitch generate ESG ratings similar but more limited in scope to reports from credit rating agencies. Figure 2 displays a mock report from Sustainalytics, including the scale used in the report. As we can see, there are fewer categories than pure credit reports. But more importantly, such ratings are not aimed at impacting lending decisions. They aim to inform investors on how exposed are portfolios to material ESG issues.

Recent initiatives have tried to enhance the scope of sustainability risk management. For instance, Ascui and Cojoianu (2019) advance a natural capital (in the sense of ecosystem) credit risk assessment framework. Still, one crucial condition for banks to develop and implement robust sustainability credit rating systems is high-quality, actionable information as inputs. Thompson and Cowton (2004) show that bankers attach importance to firms' annual reports, notwithstanding their traditional limitations as a source of information on corporate environmental impact. They also note that some desire extensions to environmental disclosure, even if those desired developments are relatively narrow, mirroring banks' principal interest in protecting their loans.

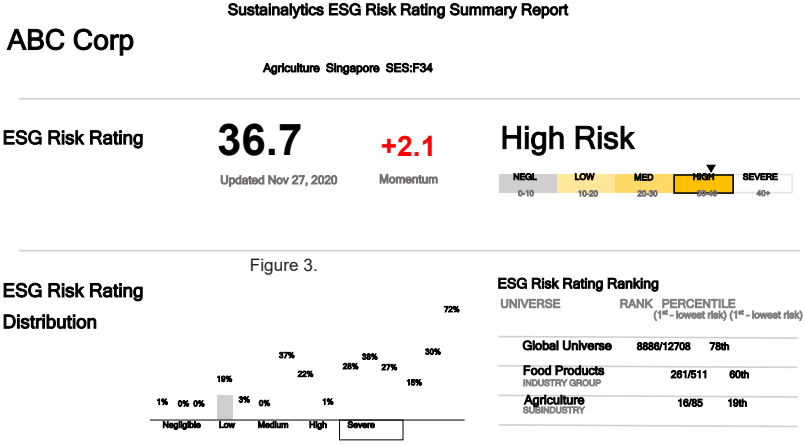
Since the mid-2000s, ESG indicators have emerged as the primary standard for disseminating financial and nonfinancial companies' social and environmental impact. However, there are two main barriers to ESG indicators as the central criteria for informing lending decisions: such indicators are mostly related to downside risk (Zeidan, 2022a), and there are currently over 360 ESG accounting standards globally (and ESG-related guidelines, such as regulations and standards, have grown from around 700 in 2009 to more than 1,700 today, according to The Economist.[3]) Some authors (e.g., Rezaee and Tuo, 2019; Busco et al., 2020) claim that societies face some form of ESG trap, the low information content of environmental reports that limits

[1] https://equator-principles.com/app/uploads/The-Equator-Principles_EP4_July2020.pdf.

[2] https://connect.sustainalytics.com/hubfs/SFS/Sustainalytics%20ESG%20Risk%20Rating%20-%20FAQs%20for%20Corporations.pdf.

[3] https://www.economist.com/business/2020/10/03/the-proliferation-of-sustainability-accounting-standards-comes-with-costs.

Figure 2
Mock report from Sustainalytics



Peers Table

Peers (Market cap $18.0 - $25.7bn)	Exposure	Management	ESG Risk Rating
1. Archer-Daniels-Midland Co.	58.7 High	46.3 Average	34.2 High
2. ABC Corp.	65.4 High	48.7 Average	36.7 High
3. New Hope Liuhe Co Ltd	59.2 High	23.9 Weak	46.4 Severe
4. Wen's Foodstuff Group Co., Ltd.	59.0 High	14.5 Weak	51.3 Severe
5. Tongwei Co., Ltd.	59.0 High	12.1 Weak	52.5 Severe

Negligible	Low	Medium	High	Severe
0 - 10	10 - 20	20 - 30	30 - 40	40+

the ability of investors and financial institutions to improve decision-making related to nonfinancial indicators.

Some initiatives aim to improve this landscape. The Corporate Sustainability Reporting Directive (CSRD) is the new European Union (EU) legislation requiring all large companies to publish regular reports on their environmental and social impact activities. Nearly 50,000 companies (15,000 in Germany alone) in the EU will be required to submit their report aligning with the CSRD on January 1, 2025, for the 2024 financial year. The CSRD is one of the measures within the Sustainable Finance Package adopted by the European Commission in April 2021 to help improve money flow toward sustainable activities across the EU.

However, although information content is undoubtedly a significant challenge, it is not the only barrier to robust sustainable lending processes. In the remaining section, we describe the primary methods for building credit rating systems and detail previous attempts at developing such methods.

2.1 Methods for sustainable lending

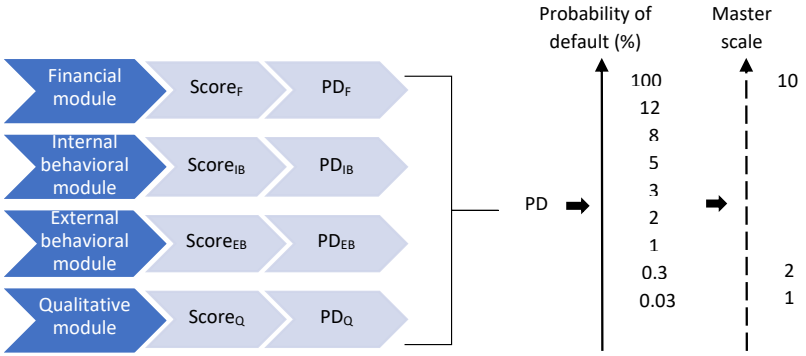
The steps for building a standard credit rating model are identification of the segment of interest (perimeter of applicability), definition of the event to be forecast (the default), analysis of the internal and external regulatory framework, analysis of processes, information technology procedures and data to support the credit unit and data availability, analysis of the portfolio, definition of the modality for dealing with outliers and exceptions, comparison and discussion with the business and credit experts (Izzi et al., 2012). Figure 3 describes the typical approach for building a credit rating model.

Credit ratings use quantitative and qualitative information based on different methods. These include multi-criteria decision-making (MCDM), as in the case of Zeidan et al. (2015), based on an analytical hierarchic process (AHP), Roy and Shaw (2021), designed from a fuzzy TOPSIS, and Nabeeh et al. (2021), developed through a Neutrosophic Multiple-Criteria Decision-Making Framework (N-MCDMF).

Bonsall et al. (2017) show that differences in the credit rating agencies' methodologies result in differences in rating properties. In particular, they focus on differences in information processing constraints between a rating agency that utilizes qualitative analysis and direct access to borrowers' management in its rating process compared to one that does not. They also find that as information uncertainty about borrowers increases, the ratings accuracy, informativeness, and timeliness of the agency without direct access decrease relative to the agency with that access.

This direct access to detailed information about borrowers motivates the

Figure 3
Main steps in the development of statistical models



Source: Izzi et al. (2012).

Sustainability Credit Score System (SCSS, Zeidan et al., 2015). It is based on the analytic hierarchy process methodology. Its goal is to inform lending decisions by integrating sustainability into regular credit reports. With a bank as its end user, the SCSS would work by inducing changes in lending decisions regarding credit availability and interest rates. For instance, banks that complement their regular credit score with a sustainability one would have better information to decide on the price and quantity of lines of credit. Also important is that the central condition for the generalization of the SCSS is the use of private information. We argue that this is one of the characteristics that makes the system stand out as an improvement over ESG ratings.

2.2 Private versus public information, private versus public companies

There is a common misconception that credit ratings rely almost exclusively on quantitative information, with their outputs robustly derived from unambiguous statistical models. But as Ganguin and Bilardello (2005) have noted: "a diligent credit evaluation of a company's financial performance and profile cannot and should not be done without an understanding of the level of qualitative risk inherent in the entity." ESG ratings are mainly designed for use by investors, so, naturally, they are based on public information. It is also why several sustainability-related ratings are only available for public companies; they are mostly (but not exclusively) built from self-reported ESG indicators.

The SCSS has been designed to encompass ratings for all types of companies, public and private, large and small. Its methodology is initially designed for account managers of commercial banks to input the required information to generate the final scores. Thus, it uses account managers' private information on their clients. Account managers are responsible for filling out the questionnaires, which tap on their private information, that generate standard scores. In that sense, it is similar to how regular credit ratings are implemented.

Generalizing the SCSS requires resolving the tension between public and private information. Limiting it to the former would likely make it easier to redesign it but would limit its adoption by commercial banks and other financial institutions. After all, only a fraction of banks' clients are listed companies. Institutions must create credit reports for all their lending operations. For small and medium-sized companies, banks mainly acquire credit bureaus' reports when available and complement them with proprietary information or build their own reports.

There are significant limits to the public information about companies' environmental and social impacts. Robust credit reports require consistent data for backtesting, but firms' ESG disclosure practices are not uniform (Zeidan, 2022a). For instance, firm-level variables explain most variation in ESG disclosure (Yu and Luu, 2021), disclosure scores are sensitive to outliers (Baldini et al., 2018), and profitable and mature firms disseminate more climate-related information (Drempetic et al., 2020).

Standardized private information allows for the evolution of robust credit ratings. Part of the appeal of the SCSS is that it is supposed to be used by commercial banks that can train their account managers and improve the ratings from each round of ratings generated by them. Thus, the main challenge with generalizing the SCSS for different end users is dealing with disparate expectations, abilities, and access to private information. In Section 3, we describe how we resolve these issues, although only higher adoption would allow researchers to check for the robustness of the final rating system.

2.3 How do banks incorporate information into "green" lending today?

There is no significant need to motivate green credit rating systems as many firms face climate risks. However, there is still knowledge to be gained by relating the recent scientific literature to the SCSS. There is evidence that climate and credit risk are highly correlated (Capasso et al., 2020), which could drive banks to accelerate the incorporation of climate factors in regular credit risk models. In fact, it is somewhat of a puzzle why that has not already happened, with some authors (e.g., Zeidan, 2022b) arguing that orga-

nizational inertia is a more substantial barrier than previously thought. More importantly, Capasso et al. (2020) find that the positive relationship between corporate default risk and carbon footprint is stronger following the Paris Agreement, which may support the argument that banks must adapt or die.

Some of that risk is already priced in the bonds issued by the largest companies. Apergis et al. (2022) find that firms within the S&P 500 with solid ESG scores benefit from lower bond spreads and better bond ratings than firms with weaker ESG scores. Of course, most companies worldwide do not issue bonds, even though the market for green bonds is maturing (e.g., Ehlers and Packer, 2016, 2017; Hachenberg and Schiereck, 2018; Chang et al., 2020) and expanding (Barua and Chiesa, 2019).

There is one counterargument to the need for commercial banks to incorporate nonfinancial performance into standard credit rating systems: banks already charge higher interest rates to firms with higher environmental risks.

Weber et al. (2010, 2015) indicate that sustainability criteria can be used to predict the financial performance of a debtor and improve the predictive validity of the credit rating process. Weber (2012) notes that Canadian banks systematically examine environmental risks for credits, loans, and mortgages but without clear benchmarks (at the time).

In addition, Fard et al. (2020) show, using a sample of 27 countries between 1990 and 2014, that banks charge higher interest rates and adjust other contractual features of their loans when lending to firms facing more stringent environmental regulations. They also show that firms facing such regulations have fewer participants in their loan syndicates, higher bankruptcy risk, and lower credit ratings, despite reducing their leverage. Thus, they conclude that banks' lending practices are already environmentally sensitive. In addition, Guiral et al. (2021) suggest that lenders use CSR performance as a proxy for borrowers' integrity. However, although Semet et al. (2021) confirm that extra-financial criteria are integrated into bond pricing, they find that credit rating agencies undermine the impact of climate change and environmental topics on a country's creditworthiness.

Another relevant empirical evidence for the present context comes from Wellalage and Kumar (2021). On a sample of 3,915 unlisted firms, they find that companies with better environmental performance received approximately 6.4% higher loans (as a ratio of total sales) but that environmental performance does not affect loan duration and collateral requirement, indicating no spillover economic effect of corporate environmental performance on loan conditions.

Although there is evidence that ESG indicators are already incorporated into credit risk models, banks don't necessarily do that systematically. For

instance, Zhou et al. (2022) show that information and expertise asymmetries limit commercial banks' abilities to evaluate the credit risk of green lending. Moreover, almost all the discussions on "green" lending and bonds focus on downside risks from incorporating ESG "risks" (for a discussion on why ESG indicators are not risk factors, see Zeidan, 2022a) into regular credit risk models.

In the end, we have indirect evidence that commercial banks already use nonfinancial information for lending decisions, which isn't surprising. Still, the strongest evidence is that banks use that information indirectly. Take Fard et al. (2020), for instance. They find that financial institutions use environmental regulation as a proxy for climate-related risks. Banks control for some of the ESG indicators in corporate lending. We argue that generalizing credit score systems to incorporate socio-environmental information comprehensively for banks can make financial markets more relevant in mitigating climate change. In addition, rating systems should incorporate upside possibilities and not solely downside risks. Banks don't have robust incentives to use ESG indicators in lending decisions because that would only make credit scarcer and more expensive. Ideally, banks would reduce interest rates for more sustainable and innovative companies through better credit ratings and not only look at increased default probabilities. Thus, we discuss how to generalize sustainability credit systems based on the SCSS (Zeidan et al., 2015), which uses internal information and upside possibilities to generate companies' nonfinancial ratings.

3. Generalizing sustainability credit risk systems

Our goal is to describe an implementable generalized sustainability credit score system launched as a financial service open to subscribers in early 2022, the Sona Sustainability Credit Score System. It is based initially on the SCSS (Zeidan et al., 2015), but it has one crucial enhancement: we have expanded the system for any end-user interested in generating a sustainability credit report. That includes commercial banks, insurers, investors, and any type of financial institution.

The SCSS model is unique because it provides a single sustainability risk assessment framework through which companies and entities of different sizes, geographies, sectors, and industries can all be reliably measured, scored, and ranked. This system enables an analyst to compare, for example, the sustainability performance of a wind farming company in Ghana and a mining company in Norway, all on the same measurement scale.

The central tradeoffs in generalizing a credit score system refer to the nature of information and the compatibility between scores generated by dif-

ferent analysts. When used by a commercial bank, it is straightforward to train analysts or account managers who will input the data to guarantee compatibility and refine the final product. In addition, the SCSS has been tested in a single sector, the sugar industry in Brazil. Expanding the system for any industry in all countries and the information asymmetry across end users provides formidable challenges.

The SCSS is a straightforward application of an analytical hierarchical process. It is composed of six matrices for the six sustainability dimensions, each matrix $A_i = (a_{ij})_{1 \leqslant i,j \leqslant n}$, in which

$$a_{ij} = \begin{cases} 1, & \text{if } i = j, \\ 1/a_{ji}, & \text{if } i \neq j, \end{cases} \tag{1}$$

and a weighting matrix for the six dimensions. For each dimension, A_i is composed of 5 questions, and a final questionnaire of 30 questions is developed from the analytical model, yielding a final sustainability credit score that ranges from 0 to 1 (Zeidan et al., 2015). For each question, analysts must choose one of three options, representing the three main paths for sustainable development: business as usual (BAU), sustainable business (SB), and future sustainable business (FSB). As Zeidan et al. (2015) describe, BAU refers to the present stage in which the industry practices are directly related to past practices, which may or may not be sustainable; SB is a future stage (five-year horizon), resulting from the adoption of new sustainable practices by firms. These are mainly derived from emerging technologies, new commercial practices, and evolving legislation; FSB is a future stage (20-year horizon) marked by the foreseen role of the industry in a sustainable path that would allow continuing economic, social, and environmental development.

There are several challenges to generalizing the SCSS from closed to open platforms, from single to multi-industries, and from one to any country. The crucial ones are the number and content of the sustainability paths must be redefined, questions and weights must be redesigned, and a new set of country-specific weights must be created. In the following subsection, we provide a guide for creating an open platform where any end user can generate an organization's sustainability credit score.

3.1 The initial guide to inputting information for the SCSS

The model is based on relative comparisons. Thus comparisons between indicators must be consistent for the results to be meaningful. The analyst must choose, for each indicator, one of four options: NBAU (which indicates that a company is worse than the industry's average), BAU, SB, or FSB. The

simplest way to interpret these options is to rank companies as: below average, average, above average, and one of the best. For each of the 18 indicators, which expands on the initial set in Zeidan et al. (2015), an analyst must choose one of the four alternatives for the company under examination.

But before answering the specific questions regarding the company for which the sustainability credit rating is being generated, the analyst must answer a few questions that will establish the comparison group for the company under examination.

The antecedent process is due to the credit rating, as is standard, making relative comparisons. Thus, there must be clear benchmarks for each company to be ranked. There are two categories to build the comparison groups (usually for companies in the same industry).

The first category determines if the evaluated company faces the steepest, major, or minor sustainability challenges. For that purpose, three primary variables must be considered: where the company is located, the industry that is the primary source of profits for the company (for instance, by considering the NAICS or SIC identification codes), and the relevant products or services that are the primary sources of environmental and social issues.

It should be noted that the system is qualitative, as is the case with many facets of credit rating systems. In that sense, there are no unique, unambiguous criteria for some classifications below. Still, the system is robust as long as analysts are consistent (as the number of responses increases, consensus calls can be developed to improve the system).

Thus, to make the process of filling out the questionnaire simple and efficient, the analyst must consider the binary choices below:

Region 0 if the company operates in a region with low-quality institutions; 1 otherwise.
Industry 0 if the industry is rife with environmental or social challenges (mining, oil & gas, land-intensive agricultural production, etc.); 1 otherwise.
Products 0 if the production and sales of the firm's primary goods and services bring significant negative externalities; 1 otherwise.

Usually, there will be a strong correlation between industry and products, but not always. For instance, a company that repairs oil platforms may be classified as part of an industry rife with environmental challenges. Still, their services may not pose significant challenges to the ecosystem.

The initial classification will result in the following comparison groups, ordered through the sum of the binary variables ($S = \text{Region} + \text{Industry} + \text{Product}$; $0 \leqslant S \leqslant 3$):

1. The most significant sustainability challenges ($S = 0$)

2. Major sustainability challenges ($S = 1$)
3. Minor sustainability challenges ($S \geqslant 1$)

The second goal is related to the information at the analyst's disposal. There are three possible alternatives: no company-specific information ($D = 0$); low-quality information ($D = 1$); and high-quality information ($D = 2$). In many cases, there will not be detailed and trustworthy information about some indicators ($D = 0$), but there will be information about others ($D \geqslant 0$). The standard classification when there is no actionable information for a certain indicator is BAU. When there is information available, there are two options:

(a) Low-quality information ($D = 1$): this category incorporates company-generated data that cannot be audited, secondary information, such as reports from industry associations that is not detailed, or other types of information that are better than having no information but cannot be trusted wholesale.
(b) High-quality information ($D = 2$): data tied explicitly to the indicator under consideration from reputable sources that can be trusted at face value. Data generated by the company can be classified as high-quality if the information is transparent; data cannot be easily manipulated and/or reputable third parties have supervised or audited the data generation process or final reports.

The comparison groups above lead to the following rules for filling out the questionnaire. For a specific indicator:

FSB Analysts should classify companies in this category only if high-quality information is available.
Even so, when $S = 0$, this category is unavailable unless there are exceptional circumstances.
When $S = 1$, companies must be in the top 5% among their comparison group to be classified as FSB. Companies should be the main driving force behind decarbonizing their industries for that particular indicator, or they should present an innovative way to deal with the issue at hand.
When $S \geqslant 1$, companies must show actual pursuits to lower their negative environment or social impact to be classified as FSB. Information should describe the actions taken by the companies and how it tracks the effects of their measures.
SB When $S = 0$, this category is only available if high-quality information indicates that the company is committed to reducing its harmful environmental or social impact. Information should describe the actions taken by the com-

panies and how it tracks the impact of their measures. There should be clear evidence that the company does not incur in greenwashing.
When $S = 1$, this category is only available if the information indicates that the company is committed to reducing its deleterious environmental or social impact. Information should describe the actions taken by the companies and how it tracks the effects of their measures.
When $S \geqslant 1$, the analyst should classify the company as S.B. if it exceeds that indicator's industry standards.

BAU BAU is the standard answer if the analyst has no reason to consider that the company is different from its peers for that indicator.
If high-quality information is available, a company should be classified as BAU if there are no significant risks to its operations or society about the specific indicator under consideration.
If there is low-quality information, the analyst must consider material risks to society from the company's operations regarding that indicator.

NBAU The analyst should select NBAU with evidence of higher risks than comparable companies for the indicator under consideration, e.g., evidence of repeated fines about the issue, the use of old production methods, the hidden effects of their operations, and active opposition to improved regulatory standards.

Below are some developed questions so analysts can rank companies regarding their nonfinancial performance. Unfortunately, there is no initial way to generate questions that yield unambiguous responses. However, that is not a significant hurdle. As with every credit score system, questions are supposed to be refined as results accumulate. For instance, if there is an indication that the dispersion of the answers from analysts for certain companies is exceptionally high, the questions can be rewritten to limit ambiguity.

The examples below describe the first version of the questions related to the eco-efficiency dimension (Figure 4).

3.2 Adding options and further changes after initial tests

The five key areas of further development required to generalize the SCSS covered in this paper are the inclusions of country impact, industry and sector impact, additional rating answer options, sustainability forward default probability, and credit rating score comparisons. Within each area are certain limitations and testing requirements in the application to company ratings to normalize relative to the rating of industry peers.

Figure 4
Initial version of eco-efficiency questions for the generalized SCSS

1. Eco-Efficiency			
NBAU	BAU	SB	FSB
Water management			
Does not meet the legal requirements	Compliance with law	Has concrete actions to make consumption and water capacity compatible	Leader in its industry regarding water management
Waste management			
Does not meet the legal requirements/ poses a grave risk to adjacent ecosystems.	Compliance with law/ Accepts the possibility of disasters	Creates little waste and/or promising practices impede potential disasters.	Leader in its industry regarding waste management. E.g., reuses most waste generated; uses it as biofuel in small electricity generation plants, etc.
Land use, including deforestation			
Company is set on contested areas, regular conflicts with locals; uncertain if operations are linked to deforestation	Compliance with the law and/or following standard practices.	Investments in land revitalization, including reforesting in company land, if applicable. Must go beyond regulatory standards. Publishes comprehensive public reports.	Has concrete actions to foster biodiversity; publishes and tracks biodiversity action plans (focus on actions); prioritizes, monitors and schedules actions related to land-use improvements.
Disaster Resilience			
The company's operations are particularly prone to natural disasters like floods and hurricanes.	Compliance with the law and/or following standard practices.	Risk management practices include concrete plans for natural disasters and built-in redundancies. Service provision may not suffer from disaster risks. The company is well-insured financially.	Has concrete actions to mitigate natural disaster risks, working alongside the community and regulators to maintain its "social capital" even if natural disasters occur.
Certifications			
Company does not have standard certifications and thus cannot access specific markets. Company is regularly fined for lack of environmental certifications.	Compliance with the law and/or following standard practices.	Company has advantages over its competitors for holding certifications that are not standard. Company works with NGOs and other stakeholders to improve its operations and the supply chain	Company is proactive in disseminating best practices. Holds almost all certifications and is the industry leader in the subject.

3.2.1 Country impact

When starting a new company rating, the user is asked to select the country in which the company being rated is based or headquartered. There are 193 countries on the list of country options. According to the U.N. Country Sustainability Report, each of these countries is ranked by their overall score. The overall score measures the progress toward achieving all 17 Sustainable Development Goals (SDGs) as a percentage of SDG achievement, where a score of 100 indicates that all SDGs have been achieved. At the top of this list in descending order are Finland, Denmark, Sweden, and Norway, with scores ranging from 86.51(%) to 82.35(%) as of 2022.

The country selected impacts the company's final score being rated based on the difference between the relevant country's sustainability development score from the average (mean) score of all 193 countries, which is then divided by two. For example, if the country of the company being rated is Japan which has a country score of 79.85(%), this is subtracted from the average (mean) score of 62.09(%) and divided by 2, giving a final country impact score of +8.88(%). Suppose the company's country score is lower than the average (mean) country score. In that case, this will reduce the final sustainability rating of the company in question. For example, suppose the country of the company being rated is Liberia, with a 48.65(%) score. In that case, this is subtracted from the average (mean) score of 62.09(%) and divided by 2, giving a final country impact score of −6.72(%).

The current approach is pragmatic. The final country impact score is added to (or subtracted from) the result of the Sustainability Credit Score System, producing a final score and rating. Therefore, two companies that are identical in all other sustainability metrics aside from the countries in which they are based have different sustainability credit scores. It seems unfair to discriminate against companies geographically, but this is today's market reality. The current approach approximates the difference between sovereign ratings, incorporating these into individual credit ratings, as is standard practice.

3.2.2 Industry and sector impact

Similarly to the country's impact score, the industry and sector also affect the final sustainability credit score.

Economic activities can broadly be classified in several ways. One of the more widely used classification methods puts industries into one of three sectors: primary (extraction and agriculture), secondary (manufacturing), and tertiary (services). Some add quaternary (knowledge) or quinary (culture and

research) sectors. Different industry classification methods include the International Standard Industrial Classification of All Economic Activities (ISIC), the North American Industry Classification System (NAICS), the Standard Industrial Classification (SIC), and the Bloomberg Industry Classification Standard (BICS). Users are asked to select the relevant industry from a list of 60 options.

All industry option belongs to one of the three sectors. The weightings differ for each sector based on the companies' exposure to the indicators within the six dimensions. For example, industries in the manufacturing sector have the highest exposure to environmental dimension impacts (environmental protection and eco-efficiency). In contrast, service companies have higher exposure to social dimension impacts (socio-economic and social progress).

3.2.3 Additional rating answer options

The four rating options initially available as part of the SCSS are NBAU, BAU, SB, and FSB. Two additional rating options are introduced: Sustainability Default (SD), indicating an adverse sustainability event in the past 12 months, and a Not Applicable (N/A) option, where the specific indicator in question is not relevant to the entity being rated.

The inclusion of the Sustainability Default rating options in the analytical methodology increases the lower end of the range of possible results (of the sustainability credit score) from 1/100 (1%) up to 100/100 (100%). An SD rating represents a score of 1%, NBAU is 25%, a BAU of 50%, S.B. 75%, and FSB 100%. This scale allows for a standardized measurement framework that can be reliably and intuitively tested across companies and sectors.

Moreover, the N/A option accounts for not all of the indicators across the six dimensions applies. Thus, non-relevant indicators have no impact on the final score. Finally, for consistency, the weight matrices for the AHP are standardized, as shown below (Figure 5), following Zeidan et al. (2015).

3.2.4 Forward default probability

Another feature of the generalized SCSS is the creation of credit reports that include a Sustainability Forward Default Probability, the probability of a sustainability default occurring over five years for the rated company.

A sustainability default explicitly indicates the company's exposure to adverse ESG or sustainability events. Infamous such events include the Deepwater Horizon oil spill in 2010 and Volkswagen falsifying emission tests due to poor governance resulting in a loss of $33.3 billion in fines, penalties, financial settlements, and buyback costs. It can be extended to incorporate climate

Figure 5
Weight matrices for the six dimensions and initial four options for analysts

	EE	SE	ES	EP	EG	SP
EE	1	1	1	3	3	3
SE	1	1	1	3	3	3
ES	1	1	1	3	3	3
EP	1/3	1/3	1/3	1	1	1
EG	1/3	1/3	1/3	1	1	1
SP	1/3	1/3	1/3	1	1	1

	FSB	SB	BAU	nBAU
FSB	1	1/3	1/5	1/9
SB	3	1	1/3	1/5
BAU	5	3	1	1/3
nBAU	9	5	3	1

risks, such as the severe flooding in Thailand in 2011, which disrupted automotive and technology supply chain networks, causing an estimated $46.5 billion in economic damages.

The methodology used to assess a company's sustainability forward default probability works by looking at the sustainability ratings of a database of public companies for each year over the past ten years and calculating their average percentage of sustainability default events over the period.

This methodology's primary limitation is the assumption that past averages are informative. As the landscape of ESG and sustainability is evolving rapidly, we will likely see less correlation between market responses to past climate and social events. To overcome this limitation, the plan is to conduct regression analyses on the historical sustainability performance of the universe of companies quarterly.

3.2.5 Credit rating score comparisons

For a particular company, the sustainability score is the weighted average of the 30 indicators (questions) under the six dimensions (economic growth, environmental protection, social progress, socio-economic development, eco-efficiency, and socio-environmental). This score is then adjusted for a country's impact and normalized relative to industry peers.

The final sustainability score for the entity (e.g., 77%) is matched to a corresponding final sustainability rating (e.g., A+), a credit grade equivalent (e.g., upper medium grade), and a classification of whether or not this equates to an investment grade rating or not. The final sustainability score of the as-

sessed entity corresponds to a rating between AAA (extremely strong) and D (sustainability default). All ratings between AAA and BBB−are considered 'investment grade,' and those between BB+ and D are considered non-investment grade. These assessments of company performance are not absolute but explicitly intended to be relative to the standards and performance of a company's industry peers.

The choice for this particular scoring system is straightforward: its similarity to the standard credit rating systems used by global rating agencies.

3.2.6 Initial adjustments

The primary objective of the generalized SCSS is to assess companies' sustainability and ESG exposure and opportunities, generate consistent, reliable results and provide valuable insights on the sustainability creditworthiness of a given counterparty.

Even though the goal is for a system that can be used to generate ratings for companies of all sizes, the framework of the generalized SCSS model was initially tested on a database of 100+ public companies, with over 1,000+ Monte Carlo simulations conducted in six months following the initial assessments. Although the general framework of the initial model has remained unchanged, there have been several refinements to the weightings applied to both the country and sector/industry inputs to align further the assessments and results of company performance relative to industry peers.

Macro data at the segment and geographic levels are continuously collected from academic and NGO datasets (e.g., World Bank, Transparency International, and US EPA), company disclosures (sustainability reports, proxy reports, AGM results, etc.), government databases, and other stakeholder sources regarding specific companies. For the model, essential data include weekly monitoring of controversies or sustainability default events by companies or other government entities.

The Sustainability Credit Risk Committee reviews all new industry developments and model changes. In subsequent steps, a formal in-depth quality review takes place, including quality checks of data and rating results, industry and market-lead oversight, and sustainability accounting standards and reports. Furthermore, the plan is for an in-depth review of the entire model framework to be conducted annually. This review will examine the critical issues assigned to the various dimension and indicators and the weights applied to each sector and industry model. This process may also identify emerging issues and those that have become less significant.

The framework helps to attenuate information biases by extracting private information possessed by the analysts that use the credit score system. Many

outsiders, such as account managers and analysts, have firm-specific information, but there is no structured way to extract it into a coherent framework. Remaining expertise biases could be limited by using robustness checks on the reports generated by the end users of the generalized SCSS. For instance, if dozens of analysts create reports for the same company, we can improve the model by checking for omissions in the questionnaires or patterns from the inputted answers. Finally, the system could also be used by firms, with workers independently filling out the questionnaires so managers could come out with reports for internal use.

Appendix 1 brings an example of a results report for the generalized SCSS. There, we detail all the information for the report's replication for developers that would like to create similar systems based on the present methodology.

4. Final comments

Ideally, commercial banks would generate sustainability-related ratings or modify their existing credit rating systems to incorporate nonfinancial performance explicitly. The present article details all the steps required to generalize a sustainability credit rating system (based on Zeidan et al., 2015) from a closed to an open platform.

The first step to generalize the SCSS includes adding three primary variables: where the company is located, the industry that is the primary source of profits for the company (for instance, by considering the NAICS or SIC identification codes), and the relevant products or services that are the primary sources of environmental and social issues. The second step is the inclusion of two rating answer options. Then, we determine the weightings for arriving at a sustainability forward default probability, and, finally, we make credit rating score comparisons.

The main output is the Sustainability Forward Default Probability for the rated company. That reflects the possibility of a sustainability default occurring over five years. It should be noted that the system is qualitative, as is the case with many facets of credit rating systems. In that sense, there are no unique, unambiguous criteria for some classifications below. Still, the system is robust as long as analysts are consistent (as the number of responses increases, consensus calls can be developed to improve the system).

The current model may provide a way for society to overcome the ESG trap, the low information content of environmental reports that limits the ability of investors and financial institutions to improve decision-making related to nonfinancial indicators (e.g., Rezaee and Tuo, 2019; Busco et al., 2020; Zeidan, 2022a). Although there is evidence that ESG indicators are already

incorporated into credit risk models, banks don't necessarily do that systematically (Zhou et al., 2022). We argue that the present model can help commercial banks overcome information and expertise asymmetries in evaluating the credit risk of green lending by extracting private information from account managers, analysts, insiders, and other market agents.

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A. The output of the generalized SCSS

This appendix reports calculation results for SONA Sustainability Credit Score System.

Summary – Model Information

Company Name	CSB
Country	Denmark
Model	SCSS1
Sector	Services
Industry	Education
Analyst	Rodrigo Zeidan

Rating Date	11-07-2022
Comparison Group Scores	
Country	1 or 0
Sector	1 or 0
Industry	1 or 0

Generalized SCSS Results – Summary

Final Sustainability Score	78%
Final Sustainability Rating	A+
Credit Grade Equivalent	Upper Medium grade
Investment Grade? (BBB−or above)	Yes

Generalized SCSS Results - Current

Environmental Protection	
Indicator	Rating
Business model	SB
Greening of supply-chains	SB
CO2 and other climate-related emissions	BAU
Environmental auditing and certifications	BAU
Energy consumption	SB

Eco-Efficiency	
Indicator	Rating
Water management	SB
Waste management	SB
Land use	N/A
Disaster resilience	N/A
Certifications	SB

Economic Growth	
Indicator	Rating
Corporate governance	SB
Innovation and long-term viability	BAU
Quality of economic growth opportunities	NBAU
Equipment and machinery	SB
Types of consumers	SB

Socio-Environmental	
Indicator	Rating
Reporting on labor and environmental issues	BAU
Labour and environmental model	SB
Corruption	FSB
Funding	BAU
Industry associations	FSB

Social Progress	
Indicator	Rating
Social License to Operate	BAU
Regulatory changes	BAU
Sourcing	SB
Diversity	BAU
Relationship with stakeholders	SB

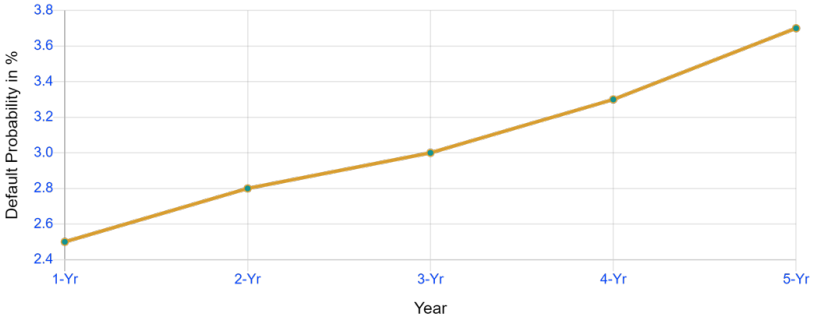
Socio-Economic	
Indicator	Rating
Labor costs	BAU
Labor training and conditions	SB
Worker “s health and risk of accidents	SB
Outsourcing and supply chain risks	N/A
Data disclosure	SB

Generalized SCSS Results – Forecast

	1-Year	5-Year
Sustainability Default Probability	2.5%	3.7%
Sustainability Rating	A+	A+
Percentile	25%	25%

	Forward Sustainability Default Probability
1-Year	2.5%
2-Year	2.8%
3-Year	3.0%
4-Year	3.3%
5-Year	3.7%

Sustainability forward default probability



Long-Term Rating Comparisons

Description		Value(pts.)	SCSS long-term
AAA	Prime	An obligor has EXTREMELY STRONG capacity to meet its sustainability commitments.	95 to 100
AA+	High grade	An obligor has VERY STRONG capacity to meet its sustainability commitments. It differs from the highest-rated obligors only to small degree.	90 to less than 95
AA			85 to less than 90
AA-			80 to less than 85
A+	Upper Medium grade	An obligor has STRONG capacity to meet its sustainability commitments but is somewhat more susceptible to the adverse effects of changes in circumstances than obligors in higher-rated categories.	75 to less than 80
A			70 to less than 75
A-			65 to less than 70
BBB+	Lower Medium grade	An obligor has ADEQUATE capacity to meet its sustainability commitments. However, adverse conditions or changing circumstances are more likely to lead to a weakened capacity of the obligor to meet its sustainability commitments.	60 to less than 65
BBB			55 to less than 60
BBB-			50 to less than 55
BB+	Non-Investment Grade	An obligor is LESS VULNERABLE in the near term than other lower-rated obligors. However, it faces major ongoing uncertainties and exposure to adverse conditions, which could lead to the obligor "s inadequate capacity to meet its sustainability commitments.	45 to less than 50
BB			40 to less than 45
BB-			35 to less than 40
B+	Highly Speculative	An obligor is MORE VULNERABLE than the obligors rated "BB," but the obligor currently can meet its sustainability commitments. Adverse conditions will likely impair the obligor "s capacity or willingness to meet its sustainability commitments.	45 to less than 50
B			25 to less than 30
B-			20 to less than 25
CCC	Extremely Speculative	An obligor is CURRENTLY VULNERABLE and is dependent upon favorable conditions to meet its sustainability commitments.	15 to less than 20
CC		An obligor is CURRENTLY HIGHLY VULNERABLE.	10 to less than 15
C		An obligor is CURRENTLY HIGHLY VULNERABLE to sustainability breach	5 to less than 10
D	In default	An obligor has failed one or more of its sustainability obligations (rated or unrated) with negative results.	0 to less than 5
n.r.	Not rated	No rating has been requested, or there is insufficient information on which to base a rating.	Not applicable
r.w.	Rating withdrawn	The sustainability rating was withdrawn.	Not applicable

Is replacing standard investments with ESG substitutes a good choice?

Ricardo de Souza Tavares[†]
Joao Frois Caldeira[‡]

Abstract We compare traditional portfolio selection strategies with traditional stock market indexes in their standard and ESG versions. In addition to the comparison of 12 indexes from different markets in their ESG and standard versions. To compare the portfolios we use conventional performance measures, and the results show that replacing the indexes with their ESG versions does not detract from performance in terms of the Shape ratio and other measures. In general, there is no statistically significant difference between the returns of the indexes and the portfolios built with these indexes compared to those using the standard versions. So that the investor concerned with environmental and social issues can replace their equity market investments with ESG assets without harming their financial performance.

Keywords: ESG; SRI; Portfolio selection.
JEL Code: G11.

1. Introduction

Companies' environmental, social, and governance (ESG) policies have gained much visibility in recent years from different perspectives: consumers with greater social and environmental awareness are interested in transacting with companies with good practices; investors are trying to understand how the adoption of ESG practices can impact the company's results; governments and regulators interested in practices that maximize the general welfare.

Nevertheless, taking away the welfare gains that transacting or investing in companies that respect social and environmental causes can bring, from an investor's point of view, how profitable or harmful to their investments would it be to choose assets that follow ESG guidelines? Although the topic has been the subject of much debate in recent years, this issue is far from being entirely solved. Some studies point out that ESG assets would perform better, especially showed higher returns (Edmans, 2012; Khan, 2019; Consolandi et al., 2020), others showing that there would be no change in performance (Halbritter and Dorfleitner, 2015; Naffa and Fain, 2022), or that they would have negative impacts on investments' returns (Hübel and Scholz, 2020).

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[†]University of Arizona, USA: tavares@arizona.edu
[‡]Universidade Federal de Santa Catarina, Brazil. joao.caldeira@ufsc.br

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Recently, ESG indexes have been created to different markets to measure the performance of companies with good practices, excluding from these indicators assets issued by companies that do not adopt environmentally friendly actions and that commercialize or produce products harmful to health and human well-being such as tobacco and weapons. We take advantage of these already established indexes to assess their performance and attractiveness to investors. For this, our study consists of two ways of evaluating these indexes:

(i) We compared the indexes in their standard and ESG versions. We used the Ledoit and Wolf (2008) test to assess whether their performances in terms of Sharpe Ratio are statistically different.

(ii) We build easy-to-implement portfolios using the SP 500 index in its standard version, ESG and Carbon Efficient for the American market, among other traditional assets customarily used to construct investment portfolios. We did the same experiment with SP EURO 350 in its standard and ESG version for the European market.

As the creation of several of these indexes is recent, their potential in terms of returns and diversification has not yet been thoroughly evaluated. Thus, what is proposed in this article is the evaluation of the inclusion of these indexes in place of their traditional versions in portfolio selection strategies. Further to evaluate them by traditional measures such as average return, volatility, Sharpe ratio, Sortino ratio, and Omega ratio. In addition, to compare the statistical difference of performance (using Ledoit and Wolf (2008) test) of well-defined indexes in their ESG and standard versions. Our goal is to check if the investor can replace her assets with socially responsible similar ones without being harmed or having a worse performance on her investments.

We used 12 indexes in their standard and ESG versions to evaluate their performance difference through the Ledoit and Wolf (2008) test. In addition, we built the $1/n$, minimum-variance, mean-variance with and without short selling, and Volatility Timing and Reward-to-Risk Timing portfolios from Kirby and Ostdiek (2012) for the American and European market with SP 500 and SP EURO 350 in their standard and ESG versions representing the equity market. Our results show that the investments does not perform worse when choosing ESG substitutes and that in some cases may even benefit (in terms of financial performance) from this.

2. Environmental, Social, and Governance (ESG) and Financial Performance

The literature on environmental, social, and governance (ESG) in Finance has gained much space in the academic debate. There are countless works dealing with the subject, either from the point of view of the market as a whole (Pedersen et al., 2021) or analyzing its application and results at the level of assets or firms (Clementino and Perkins, 2021; Aouadi and Marsat, 2018).

Starting with the characterization of an ESG market as a whole, Pedersen et al. (2021) created a theoretical model that enabled them, through the environmental, social, and governance (ESG) score of different stocks, to have information about the fundamentals of companies. When solving the investor's portfolio problem, they find the ESG-efficient frontier (using the highest attainable Sharpe ratio to adapt the capital market theory to the ESG case). They also highlight the costs and benefits of responsible investments characterized by ESG assets.

Analyzing individual companies, Aouadi and Marsat (2018) find evidence that higher corporate social performance has an impact on market value only for large companies located in countries with greater press freedom, where free internet search is possible and more frequent. Khan (2019) investigate the relationship between the companies' ESG performance and their financial performance, finding a positive relationship between them. While Consolandi et al. (2020) found ESG momentum has a significative impact on stock performance and the market would reward more companies operating in sectors with a high level of ESG concentration materiality. Edmans (2012) showed corporate social responsibility has a positive impact on stock returns and that we can use the job satisfaction levels among the predictors of future stock market performance.

Through company ESG ratings, Auer and Schuhmacher (2016) analyze the performance of socially responsible investments in the Asia-Pacific region, the United States, and Europe. The authors showed that active selection of high or low rated stocks does not provide superior risk-adjusted performance than passive stock market investments across all regions, industries, and ESG criteria. Moreover, in the Asia-Pacific region and the United States, investors who focus their investments in ESG assets have their strategies performing similarly to the broad market. While in Europe investors face a cost in directing their portfolios towards socially responsible investments. Assessing the relationship between ESG indicators and financial performance, Duque-Grisales and Aguilera-Caracuel (2021) study the Latin American market, pre-

cisely the results of multinational companies in this emerging market. Based on their results, the authors argue that investing in stocks with good ESG ratings would lead to greater visibility, more stakeholder recognition, cost reductions, and greater financial performance.

However, Halbritter and Dorfleitner (2015) and Naffa and Fain (2022) relates that the difference between portfolios and funds formed by high-ESG assets and the others non-high-ESG is not statistically significant, so the financial performance would not be related to the choice of assets which comply with ESG guidelines for the portfolios. Furthermore, studies such as Hübel and Scholz (2020) went in another direction, demonstrating that assets with low ESG ratings outperform high-ESG stocks. Analyzing the beginning of the pandemic period Folger-Laronde et al. (2020) suggests that socially responsible assets do not have a better financial performance, especially in market downturns. Concerned with the effect of rating changes on stock returns, Shanaev and Ghimire (2021) show that these changes lead to non-statistically significant increases in returns in the case of ESG rating upgrades and when there are downgrades, the results are more impactful and statistically significant.

3. Data and methodological aspects

This section describes the test for statistical comparison of performance between standard indexes and their ESG versions, the procedures used to build investment portfolios and to measure their performance and the data.

Table 1
Indexes – Standard and ESG versions

Index	Ticker	Asset Class	Ticker ESG Version
SP 500	SPX	Equity	SPXESUP
S&P/ASX 200	AS51	Equity	SPAESGAN
S&P Europe 350	SPE	Equity	SPEESEP
S&P Japan 500	SPJ500	Equity	SPJESGUP
S&P Global 1200	SPGLOB	Equity	SPGESUP
S&P United States LargeMidCap	SBPCUSU	Equity	SPUSLMUT
S&P North America LargeMidCap	STPMNAU	Equity	SPNALMUT
S&P Mid-East and Africa Developed LargeMidCap	SDMXUT	Equity	SPMADLUT
S&P Mid-East and Africa Emerging LargeMidCap	SEAXUT	Equity	SPMAELUT
S&P Emerging LargeMidCap	SBPREMU	Equity	SPELMUP
S&P Global LargeMidCap	SBPRGLU	Equity	SPLESGUP
S&P Emerging Plus LargeMidCap	SEPLEMUP	Equity	SPEMPLUT

3.1 Data

The data are composed of 12 indexes in their standard and ESG versions presented in Table 1; the choice was made based on the availability of indexes during the whole period in the study. Table 2 shows the data used to construct portfolios for the American market and Table 3 for the European portfolios. The data comprises monthly values for the indexes among January 2011 and February 2022 (the last month available when the empirical work was done). Moreover, there is information for every index at every point in time.

Table 2
Indexes - American Market

Index	Ticker	Asset Class
SP 500	SPX	Equity
S&P U.S. TREASURY BOND	SPBDUSBD	Fixed-Income
Dow Jones Industrial Average	INDU	Equity
S&P GSCI Gold	SPGSGC	Gold
United States Commodity Index Fund	USCI US	Commodities
Dow Jones U.S. Real Estate Index	DJUSRE	Real Estate
Global hedge fund index	HFRXGL	Alternative
DOLLAR INDEX SPOT	DXY	Currency
SP 500 ESG	SPXESUP	Equity
S&P 500 Carbon Efficient Index (USD)	SP5CEUP	Equity

The indexes follow the methodology adopted by the S&P Dow Jones, and the monthly values were obtained through the database provided by Bloomberg. The criteria for selecting the assets that make up the indexes follow the S&P DJI ESG Scores, which contain information about company-level ESG taking into account the individual environmental (E), social (S), and economic & governance (G) aspects. More information on the methodologies and how weights are assigned or assets excluded from these indexes can be obtained from S&P Dow Jones.

3.2 Rolling window estimation

Our first step is to define the returns. In this case, for a given index I, its return is defined as follows:

$$r_t = \frac{I_t}{I_{t-1}} - 1. \tag{1}$$

Table 3
Indexes - European Market

Index	Ticker	Asset Class
S&P Europe 350	SPE	Equity
S&P GSCI Gold	SPGSGC	Gold
Global hedge fund index	HFRXGL	Alternative
Eurozone Sovereign Bond Index	SPBDEGIT	Fixed-income
S&P Eurozone Investment Grade Corporate Bond Index	SPEZICET	Fixed-income
Bloomberg Commodity Index Euro	BCOMEU	Commodities
MSCI Europe Real Estate Index	MXEU0RE	Real Estate
S&P EURO Futures Index Spot	SPEUF	Currency
S&P Europe 350 ESG	SPEESEP	Equity

The formula is the same as the case in which we are comparing the prices for two distinct periods.

The estimations of the parameters to be used in the strategies for building portfolios will follow the rolling window approach. The choice of this estimation methodology was made following DeMiguel et al. (2009) and Kirby and Ostdiek (2012) who use it in their work to predict the average parameters and the covariance matrices of returns. In this approach, there is a roll over of the sample, defined by an observation window L, in which the estimation is made covering a period that goes from $t-(L-1)$ to the present observation (t).

According to Kirby and Ostdiek (2012), this methodology is developed in order to balance the efficiency gains in using more observations with the loss of prediction accuracy when including observations from more distant times, which have little probability of synthesizing the current conditions of the Market. In the present study, the rolling window estimators $(\hat{\mu})$ will be used to forecast asset returns, with the following formulation:

$$\hat{\mu}_t = \frac{1}{L}\sum_{l=0}^{L-1} r_{t-l} \tag{2}$$

In addition to the covariance matrices:

$$\hat{\Sigma}_t = \frac{1}{L}\sum_{l=0}^{L-1} (r_{tl} - \hat{\mu}_t)(r_{tl} - \hat{\mu}_t)' \tag{3}$$

with $\hat{\sigma}^2_{i,t}$ representing the elements of its main diagonal and $\hat{\sigma}_{i,t}\hat{\sigma}_{j,t}$ the other elements when $i \neq j$.

Here, the rolling windows will cover five years of the total observations of monthly returns. There are 134 monthly observations of each index, we take their returns so that we have 133 observations, being divided into 60 in-sample observations for rolling the estimators and 73 out-sample observations.

3.3 Portfolios strategies

The portfolio selection strategies used in this article were chosen because they are approaches easy to understand and build, which can be easily adopted even by an investor without many technological resources or theoretical knowledge. Despite their simplicity, many studies such as Kirby and Ostdiek (2012) and Tavares et al. (2022) showed that they bring good results compared to the market benchmark portfolio or the naive portfolio, which in many cases is difficult to be overperformed (DeMiguel et al., 2009).

3.3.1 Naive strategy

The equally weighted strategy, whose record of first adoptions has already been shown in several applications, as seen in DeMiguel et al. (2009), with superior performance to strategies that are sophisticated and challenging to implement. The weight for each of the n assets in this portfolio is defined below:

$$\omega_{i,t}^{naive} = \frac{1}{n} \tag{4}$$

here each asset receives equal weight in the portfolio formulation, and the sum of the weights must be equal to one.

3.3.2 Mean-variance

Mean-variance optimization strategies result from combinations of weights assigned to assets that aim to achieve the lowest risk for a fixed level of return μ_0. Alternatively, they can be obtained by setting a maximum level of risk, in which case the optimization is done aiming at a maximum level of return. Two mean-variance optimization strategies will be adopted in this experiment. In one case, short selling is allowed.

The implemented portfolio will be built using the sample forecast of expected returns and covariance matrix[1]:

$$\omega_t^{mv} = \Sigma_t^{-1} \frac{\mu_t (C\mu_0 - B) + l(AB\mu_0)}{AC - B^2} \tag{5}$$

[1] For more details see Cochrane (2009)

where $A = \mu_t(\Sigma_t)^{-1}\mu_t$, $B = \mu_t(\Sigma_t)^{-1}l$ and $C = l'(\Sigma_t)^{-1}l$, here l is a vector in which all elements are equal to 1.

3.3.3 Minimum-variance

The minimum-variance strategy is a particular case of mean-variance portfolios. The reason for the elaboration of this strategy lies in the difficulty of obtaining good estimates for the expected returns, in addition to the fact that their poor specification can bring great harm to the optimization, as seen in Best and Grauer (1991). The vector of optimal weights of this approach is given by [2]:

$$\omega_t^{minv} = \frac{l'(\hat{\Sigma}_t)^{-1}}{l'(\hat{\Sigma}_t)^{-1}l} \tag{6}$$

where l is a vector of size n in which each element has value 1.

3.3.4 Volatility timing

The study carried out by Fleming et al. (2001) aimed to build alternative portfolios whose structuring does not depend on the estimation of expected returns, which is quite problematic. The authors then developed volatility timing strategies, in which portfolio rebalancing depends only on expected volatility. This methodology is highly attractive because of its ease of implementation. It does not require optimization or inversion of covariance matrices. In addition, it does not generate negative weights.

The methodology also has a parameter (η) that gives the speed of adjustment of the portfolio's rebalancing in response to changes in volatility. According to Kirby and Ostdiek (2012), if this parameter approaches zero, the portfolio takes a similar form to the naive portfolio. But if $\eta \to \infty$ the portfolio will tend to be formed only by the asset with lower volatility.

In the present study, as in Kirby and Ostdiek (2012), the parameter η will assume the following values: $\{1,2,4\}$. In addition, volatility will be calculated using sample rolling window estimates, whose weights for each asset i are given by:

$$\omega_{i,t}^{vt} = \frac{(1/\hat{\sigma}_{i,t})^{\eta}}{\sum_{i=1}^{n}(1/\hat{\sigma}_{i,t})^{\eta}} \tag{7}$$

[2] For more details see Clarke et al. (2011)

3.3.5 Reward-to-Risk timing

Considering that the previous set of strategies ignores the information that can be brought in through the expected returns, Kirby and Ostdiek (2012) create the reward-to-risk timing strategies. As in the previous case, this approach does not consider the elements off the main diagonal of the predicted covariance matrix. The authors argue that the construction of strategies disregarding such covariance matrix elements reduces the risk of extreme weights for the assets. The weights of this approach for any i asset when using sample rolling window estimation are given by:

$$\omega_{i,t}^{rw} = \frac{(\hat{\mu}_{i,t}^{+}/\hat{\sigma}_{i,t})^{\eta}}{\sum_{i=1}^{n}(\hat{\mu}_{i,t}^{+}/\hat{\sigma}_{i,t})^{\eta}} \tag{8}$$

where $\hat{\mu}_{i,t}^{+} = \max(\hat{\mu}_{i,t},0)$, which guarantees positive weights to the portfolio. The η parameters are defined similarly to the previous portfolios.

3.4 Ledoit and Wolf (2008) Sharpe ratio test

To test the statistical difference between two different portfolios or assets, Ledoit and Wolf (2008) consider i and n as returns from different assets (or portfolios), and at time t they are defined as r_{ti} and r_{tn}, respectively. A total of T return pairs $(r_{1i}, r_{1n})', \ldots, (r_{Ti}, r_{Tn})'$ given the sample can be observed. We assume that these observations are strictly stationary time series and that the return distribution does not change over time. The distribution of the mean vector and covariance matrix can be defined as:

$$\mu = \begin{pmatrix} \mu_i \\ \mu_n \end{pmatrix} \text{ and } \Sigma = \begin{pmatrix} \sigma_i^2 & \sigma_{in} \\ \sigma_{in} & \sigma_n^2 \end{pmatrix} \tag{9}$$

The sample means and sample standard deviations of the observed returns can be defined as $\hat{\mu}_i$, $\hat{\mu}_n$ and $\hat{\sigma}_i$, $\hat{\sigma}_n$ respectively.

The difference between two Sharpe ratios is:

$$\Delta = SR_i - SR_n = \frac{\mu_i}{\sigma_i} - \frac{\mu_n}{\sigma_n} \tag{10}$$

Therefore, its estimator is given by:

$$\hat{\Delta} = \hat{SR}_i - \hat{SR}_n = \frac{\hat{\mu}_i}{\hat{\sigma}_i} - \frac{\hat{\mu}_n}{\hat{\sigma}_n} \tag{11}$$

The null hypothesis is $H_0 : \Delta = 0$. Basically, we are interested in testing if this difference is statistically significant. For a detailed explanation about the test see Ledoit and Wolf (2008).

3.5 Performance assessment of portfolios

Once the universe of strategies for building portfolios is defined, some performance measures are taken to compare their performance. The first and simplest performance measure presented is the sample average,

$$\hat{\mu} = \frac{1}{T-1} \sum_{t=1}^{T-1} (\omega_t' R_{t+1}) \tag{12}$$

Another important measure, which allows the synthesis of information about the risk of each portfolio, is the sample variance, which can be computed as follows:

$$\hat{\sigma}^2 = \frac{1}{T-1} \sum_{t=1}^{T-1} (\omega_t' R_{t+1} - \hat{\mu})^2 \tag{13}$$

The standard deviation $\hat{\sigma}$ is given by taking the square root of the sample variance.

Furthermore, the performance of the portfolios can be measured through the Sharpe ratio (λ), which takes into account the risk-return ratio in its formulation and is defined as follows:

$$\lambda = \frac{\hat{\mu}}{\hat{\sigma}} \tag{14}$$

The Sharpe Ratio divides the return of an asset (or portfolio) by the asset's (or portfolio) volatility. Due to its simplicity and its easy interpretation, the Sharpe Ratio has become one of the most widely used statistics in financial analysis and the risk-adjusted performance metric. In spite of this, Sharpe ratio presents some shortcomings (Lo, 2002). For example, the Sharpe Ratio assumes normally distributed returns as it measures risk by volatility and it might lead to wrong investment decisions when returns deviate from the normal distribution. In addition, to compute the Sharpe ratio one needs the expected returns and the volatilities, that are unknown and need to be estimated statistically.

We also estimate the Sortino ratio (Sortino and Van Der Meer, 1991) that consider the standard deviation of the downside returns, and it is given by

$$\text{Sortino} = \frac{\hat{\mu}}{\hat{\sigma}_d} \tag{15}$$

where $\hat{\sigma}_d$ denotes the downside returns. Sortino and Van Der Meer (1991) argued that risk should be measured in terms of not meeting the investment target and defined the "Minimum Acceptable Return" or MAR.

The Sortino Ratio is more sensitive to negative or extreme risks than measures that use volatility. However, this measure is a modification of the Sharpe Ratio as it replaces the standard deviation by downside deviation which only considers the negative deviations from the mean or a minimum return threshold.

The last measure we consider is the Omega ratio (Keating and Shadwick, 2002) which is given by the ratio between the average gain and the average loss, defined as follows

$$\Omega = \frac{\int_{\tau}^{\infty} [1 - F(r_t)]\, \partial r_t}{\int_{-\infty}^{\tau} F(r_t) \partial r_t} = \frac{\sum_{t=1}^{T} \max(0, r_t - \tau)}{\sum_{t=1}^{T} \max(0, \tau - r_t)}, \tag{16}$$

where $F(r_t)$ represents the cumulative distribution function of the strategy return r_t and τ is the minimum return threshold. We set the target return, threshold τ, to zero as Kajtazi and Moro (2019) and as it is usual in this measure.

The Ω measure allows us to compare returns for different strategies and to rank them. The rankings depend on the interval of returns under consideration and incorporate all higher moment effects. The attractiveness of the Ω, compared to Sharpe ratio and other traditional risk ratios, is that it takes into account the entire return distribution as well as it does not rely on any particular moments in terms of value and even existence. Since Ω considers additional moments as skewness and kurtosis along with the first two moments, it produces results that vary from the other models significantly. Ranking based on Ω ratio can be similar to traditional methods when the higher moments are not too significant.

The major advantage of measuring performance with Ω is that we don't need parametric assumptions (e.g. on mean and standard deviation) and there are no constraints on the form of the underlying distribution.

4. Results

In this section, we first describe and discuss the results of applying the Ledoit and Wolf (2008) test to the indexes in their standard and ESG versions. Then, we present and discuss the results of the investment portfolios, comparing them with the stock market indexes in their standard and ESG versions for the American and European cases.

Table 4
Descriptive Statistics - Standard Indexes Versions

	Min	Max	Mean	Median	Skewness	Kurtosis	St.Dev.	Sharpe
SPX	−12.51%	12.68%	1.00%	1.53%	−0.33	1.31	3.89%	0.26
AS51	−25.89%	16.88%	0.23%	0.74%	−0.68	3.19	5.81%	0.04
SPE	−14.68%	17.03%	0.31%	0.48%	−0.17	1.13	4.70%	0.07
SPJ500	−10.06%	12.36%	0.38%	0.52%	−0.14	0.79	3.89%	0.10
SPGLOB	−13.18%	12.23%	0.69%	1.07%	−0.39	1.30	3.92%	0.17
SBPCUSU	−12.54%	12.94%	1.00%	1.50%	−0.29	1.33	3.93%	0.26
STPMNAU	−12.85%	13.03%	1.12%	1.45%	−0.32	1.44	3.95%	0.28
SDMXUT	−18.07%	14.75%	0.26%	0.71%	−0.45	0.75	5.86%	0.04
SEAXUT	−20.22%	20.27%	0.42%	0.34%	−0.29	0.29	6.87%	0.06
SBPREMU	−16.45%	12.62%	0.18%	0.46%	−0.30	0.92	4.90%	0.04
SBPRGLU	−13.54%	12.17%	0.63%	1.03%	−0.39	1.39	3.98%	0.16
SEPLEMUP	−20.07%	18.00%	0.14%	0.24%	−0.05	0.55	6.44%	0.02

Table 5
Descriptive Statistics - ESG Versions

	Min	Max	Mean	Median	Skewness	Kurtosis	St.Dev.	Sharpe
SPXESUP	−11.63%	12.69%	1.03%	1.60%	−0.28	1.11	3.85%	0.27
SPAESGAN	−24.89%	16.67%	0.55%	1.11%	−0.68	3.07	5.67%	0.10
SPEESEP	−14.55%	17.09%	0.29%	0.46%	−0.15	1.07	4.72%	0.06
SPJESGUP	−10.78%	12.45%	0.37%	0.56%	−0.19	0.70	4.03%	0.09
SPGESUP	−12.57%	11.96%	0.70%	1.21%	−0.35	1.08	3.92%	0.18
SPUSLMUT	−11.41%	12.84%	1.20%	1.75%	−0.26	1.05	3.90%	0.31
SPNALMUT	−11.87%	12.69%	1.15%	1.71%	−0.29	1.13	3.90%	0.29
SPMADLUT	−19.02%	14.97%	0.52%	0.23%	−0.51	1.21	5.43%	0.10
SPMAELUT	−22.88%	17.40%	0.39%	0.62%	−0.41	0.64	6.26%	0.06
SPELMUP	−17.06%	13.49%	0.04%	0.47%	−0.25	0.96	5.04%	0.01
SPLESGUP	−13.04%	11.67%	0.64%	1.04%	−0.38	1.15	3.95%	0.16
SPEMPLUT	−16.49%	14.25%	0.35%	0.59%	−0.21	0.85	5.07%	0.07

4.1 Comparing ESG versions with the standard ones

Table 4 presents descriptive statistics of the indexes in their standard version, while Table 5 presents the same results for the ESG versions of these indexes. By Table 5, we can notice that the index with greater maximum observed monthly return was S&P Mid-East and Africa Emerging LargeMidCap for both versions. The index with a lower minimum observed monthly return was the Australian S&P/ASX 200 in both versions. Some indexes as S&P North America LargeMidCap have the larger monthly return mean in its ESG version, while others such as S&P/ASX 200 have a greater mean return in its standard version. In both formulations, S&P Mid-East and Africa Emerging LargeMidCap are the indexes with greater volatility.

Analyzing the performance of the indexes in terms of Sharper ratio, from Table 6, we can see that the differences between the Sharpe ratios of the

indexes in their standard and ESG versions are not statistically significant at 5% confidence, except for the Australian index, in this case the difference was statistically significant. This shows us that in almost all cases, there is no real difference between choosing to invest in an index in the standard or ESG versions since the null hypothesis is $\Delta = 0$, which we accept and, therefore, we cannot say that there is any difference between the Sharpe ratios of the two formulations of the indexes, in terms of financial performance.

Table 6
Sharpe Analysis - Ledoit and Wolf (2008) test

	ESG	Usual	Difference	t-statistics	p_value
SPX	0.268	0.257	0.011	1.443	0.149
AS51	0.097	0.039	0.057	6.029	0.000
SPE	0.061	0.066	–0.005	–0.919	0.358
SPJ500	0.092	0.097	–0.005	–0.422	0.673
SPGLOB	0.178	0.175	0.003	0.609	0.542
SBPCUSU	0.309	0.255	0.053	5.563	0.000
STPMNAU	0.294	0.284	0.010	1.357	0.175
SDMXUT	0.096	0.044	0.052	1.124	0.261
SEAXUT	0.062	0.061	0.001	0.034	0.973
SBPREMU	0.008	0.036	–0.028	–2.244	0.025
SBPRGLU	0.161	0.158	0.003	0.506	0.613
SEPLEMUP	0.069	0.021	0.048	1.759	0.079

The Sharpe Ratio summarizes the relevant information on risk and returns on assets and it is a good and commonly-used measure of asset performance. Thus, we can say that the investor at least does not lose in terms of performance if he chooses to allocate his investment in ESG assets instead of them in their standard formulation. Moreover, in the case of the Australian market, the investor would even have a positive result in terms of performance by making this option. This result is in line with Halbritter and Dorfleitner (2015) and Naffa and Fain (2022), which showed that the difference between portfolios and funds formed by high-ESG assets and the other non-high-ESG is not statistically significant. Nevertheless, note that we did not compare them with non-high-ESG indexes; we only compared them with their standard version.

Table 7
Descriptive Statistics - USA assets

	Min	Max	Mean	Median	Skewness	Kurtosis	St.Dev.	Sharpe
SPX	−12.51%	12.68%	1.00%	1.53%	−0.33	1.31	3.89%	0.26
SPBDUSBD	−3.64%	8.20%	0.29%	0.21%	0.80	2.02	1.84%	0.16
INDU	−13.74%	11.84%	0.87%	0.99%	−0.39	1.51	3.90%	0.22
SPGSGC	−12.15%	12.29%	0.37%	0.05%	0.05	0.08	4.61%	0.08
USCI US	−16.93%	10.24%	−0.13%	−0.23%	−0.46	1.76	4.15%	−0.03
DJUSRE	−20.49%	13.36%	0.53%	0.60%	−0.65	2.97	4.54%	0.12
HFRXGL	−5.88%	2.88%	0.11%	0.33%	−1.12	3.30	1.27%	0.09
DXY	−4.15%	5.99%	0.18%	0.20%	0.29	0.28	1.88%	0.10
SP5CEUP	−12.77%	12.75%	1.00%	1.51%	−0.34	1.32	3.93%	0.25

4.2 Portfolio selection with SP 500 ESG and CARBON EFFICIENT-USA

In this subsection, the results of the portfolio selection with the strategies described in the previous section are presented. The results are presented with 3 different scenarios for the American case, in the first case we use the standard version of the SP 500, in the second we replace the SP 500 with its ESG version, and in the last case this replacement is made with the Carbon Efficient version of the index.

The rolling window estimators for variance and sample mean of returns are defined with $L = 60$. For the out-of-sample period, the estimations are made for each period taking into account the monthly observations of the index returns in the previous five years. Table 7 provides descriptive statistics of asset returns used in the portfolio selection problem for the American case. Table 8 describes the correlation between the assets used in the portfolios.

The performance measures for the portfolios in the out-sample period are presented in Table 9. We can see that, in all performance measures, the results in terms of performance are very close to the estimated portfolios with SP 500 in their ESG versions, and Carbon Efficient compared to the standard version. The differences are minimal in relation to the performance by all measures, i.e., mean returns, standard deviation, Sortino ratio, and Omega ratio.

In general, we note that, as described by DeMiguel et al. (2009), the naive portfolio has a good performance in all cases presented in Table 9. However, the portfolios proposed by Kirby and Ostdiek (2012) outperform the naive portfolio (or they are very close to) in almost all cases and measures, showing once again the efficiency in terms of the Volatility Timing and Reward-to-Risk Timing portfolios. When we analyze only the average return of the portfolios, the $1/n$ portfolio only loses in performance to the RWR(1) and the mean-variance portfolio with short selling. The same happens in the case

Table 8
Correlation matrix U.S. assets

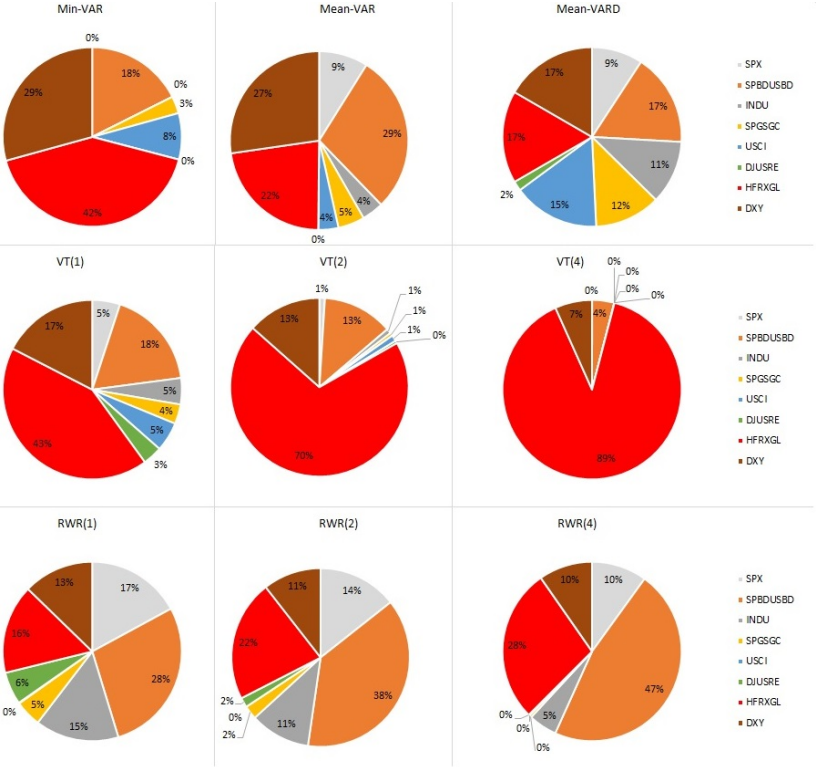
	SPX	SPBDUSBD	INDU	SPGSGC	USCI	DJUSRE	HFRXGL	DXY	SP5CEUP
SPBDUSBD	–0.28								
INDU	0.96	–0.32							
SPGSGC	0.09	0.24	0.05						
USCI	0.46	–0.35	0.45	0.35					
DJUSRE	0.73	–0.01	0.68	0.19	0.34				
HFRXGL	0.84	–0.24	0.80	0.12	0.53	0.62			
DXY	–0.37	0.21	–0.34	–0.46	–0.52	–0.26	–0.36		
SP5CEUP	1.00	–0.28	0.96	0.09	0.46	0.73	0.84	–0.37	
SPXESUP	1.00	–0.28	0.96	0.08	0.45	0.72	0.83	–0.37	1.00

where the SP 500 is replaced by its ESG version. However, we can note that for the scenario where we replace the index with its Carbon Efficient version, the naive portfolio is not defeated in terms of average return in the out-of-sample period by any other, evidence in favor of DeMiguel et al. (2009) (again showing how difficult it is to outperform the $1/n$ portfolio in terms of the average return.).

The Ledoit and Wolf (2008) test allows us to have a more technical comparison between the portfolios' performance with the standard and alternative SP 500 versions. When analyzing the statistical significance for the difference in Sharpe ratio of the portfolios built using the American market index in its ESG version and its standard version, we can see that this difference is not statistically significant, so we do not rule out the null hypothesis that the difference between the indexes is equal to zero. In cases where we have this statistically significant difference, as in the case of the Volatility Timing portfolio (4), the difference is positive; that is, the investor would be better-off by replacing the asset in its standard version with the version ESG for the portfolio composition.

For the case where we replaced the standard version of the SP 500 with the Carbon Efficient version, the results differed from the previous case. The p-values are mostly very high, and the difference between the Sharpe ratios is negative (which could indicate a lower performance if these differences were statistically significant). Therefore, we can say that although the differences between the indexes are negative, which suggests that replacing the index with its Carbon Efficient version would decrease the performance in terms of the Sharpe ratio, the differences are not statistically significant, so we can say that the hypothesis in which the strategies have equal performance in terms of Sharpe ratio using the two versions of the index can not be rejected. We have a statistically significant difference at 10% for the RWR(1) portfolio; in this singular case, we can say that the replacement harmed the portfolio's

Figure 1
Average Weights – USA normal

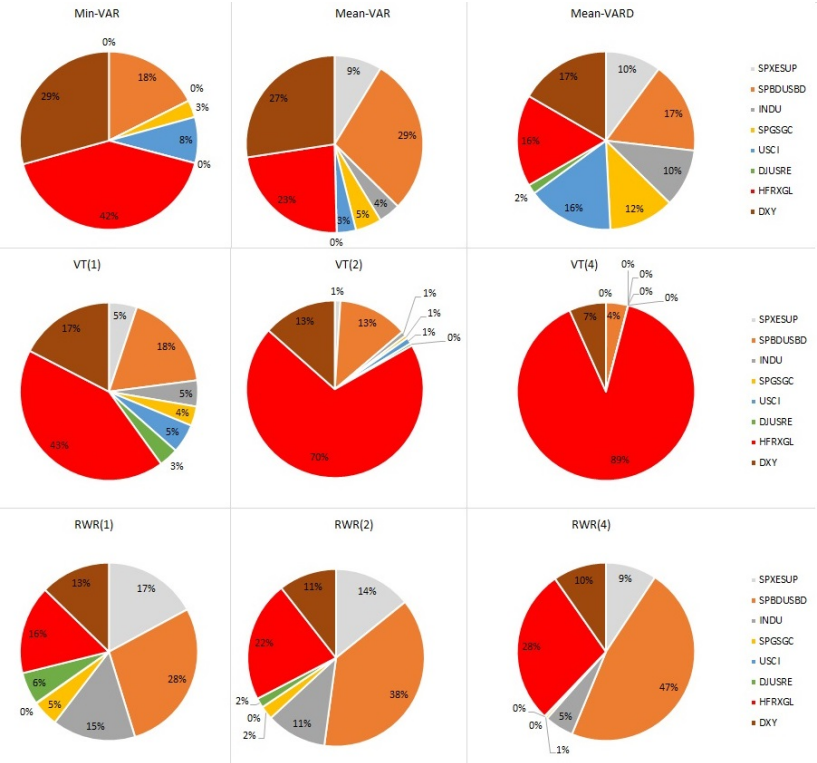


Note: The figure shows the average weights assigned to each asset per portfolio in the out-of-sample period.

performance in terms of Sharpe ratio with a 10% significance level.

Figure 1 presents the average weights of each asset for the different portfolio selection strategies for the period outside the sample when we use the SP 500 index in its standard version for the construction of portfolios; Figure 2 presents the same data for the case where we replaced the index with the ESG version; Figure 3 for the scenario where the replacement was made with the Carbon Efficient version. One can visually notice that the replacement of indexes has minimal impact on how assets are selected to compose the portfolios. We do not present the graph of the $1/n$ portfolio because it always assigns equal weights to the indexes.

Figure 2
Average Weights – USA ESG



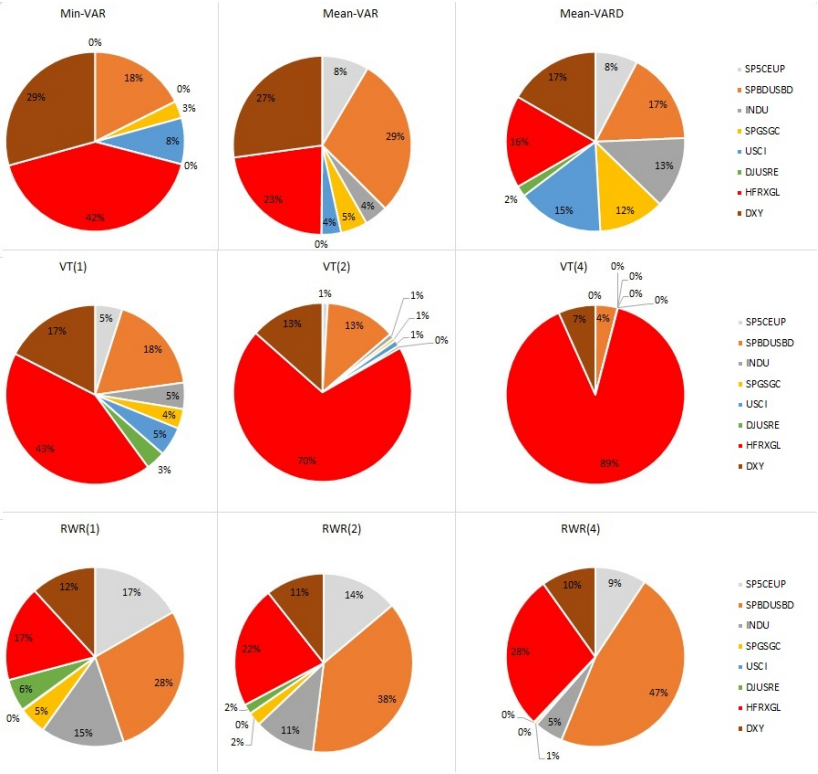
Note: The figure shows the average weights assigned to each asset per portfolio in the out-of-sample period.

4.3 Portofolio selection with EURO 350 ESG - EUROPE

Now the results for the European case are presented. Again, we compare the results obtained by the same strategies of portfolio selection from the previous subsection, but with indexes that represent some European and global markets. The analysis is made in the same way, comparing how the replacement of SP EURO 350 by the ESG version would impact the performance of investment portfolios. Unfortunately, there was no data available for the Carbon Efficient version of the index for the entire period of study, so we only compared the portfolios built using the standard version with the ESG version.

Again, the rolling window estimators for variance and sample mean of re-

Figure 3
Average Weights – USA Carbon Efficient

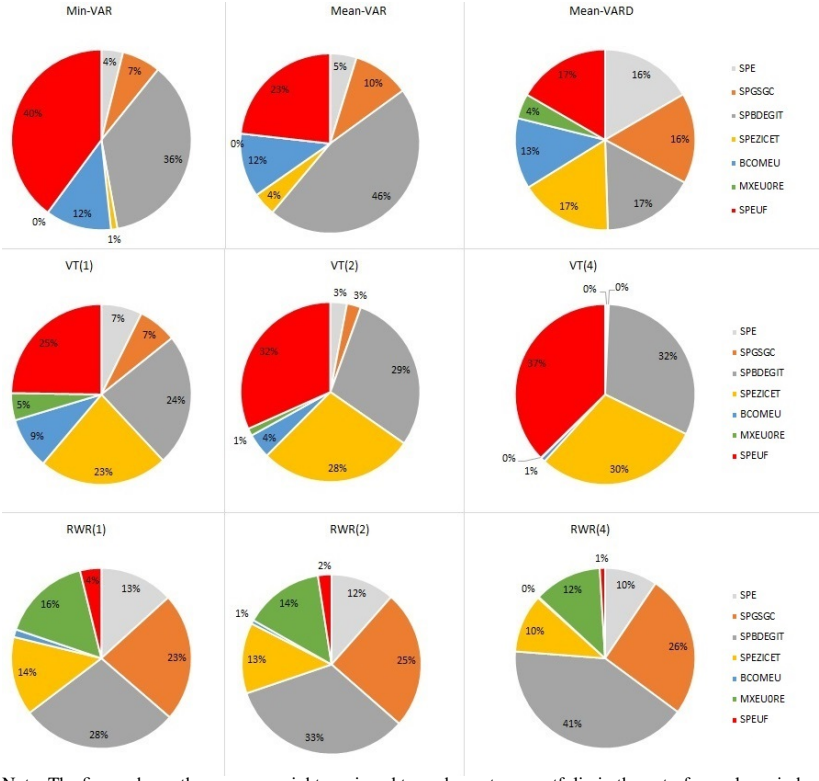


Note: The figure shows the average weights assigned to each asset per portfolio in the out-of-sample period.

turns used as inputs in the portfolio selection problem are defined with $L = 60$. For the out-of-sample period, the estimations are made for each period taking into account the monthly observations of the index returns in the previous five years. Table 12 provides descriptive statistics of asset returns used in the portfolio selection problem for the European case. Table 13 describes the correlation between the assets used in the portfolios' strategies.

Analyzing the performance of the portfolios by all the measures presented in Table14, we can see that, in general, only the Mean-VARD portfolios (mean-variance with short selling) and the Reward-to-Risk Timing portfolio (1) obtained a performance superior to portfolio $1/n$. It was expected that when short selling is allowed, the portfolio would outperform the market benchmark portfolio. However, we see that only the Kirby and Ostdiek (2012)

Figure 4
Average Weights – Europe Normal



Note: The figure shows the average weights assigned to each asset per portfolio in the out-of-sample period.

portfolio performed better than the naive portfolio. Due to different market features, we may have cases in which DeMiguel et al. (2009)'s prophecy comes true, and the portfolio $1/n$ is almost unbeatable.

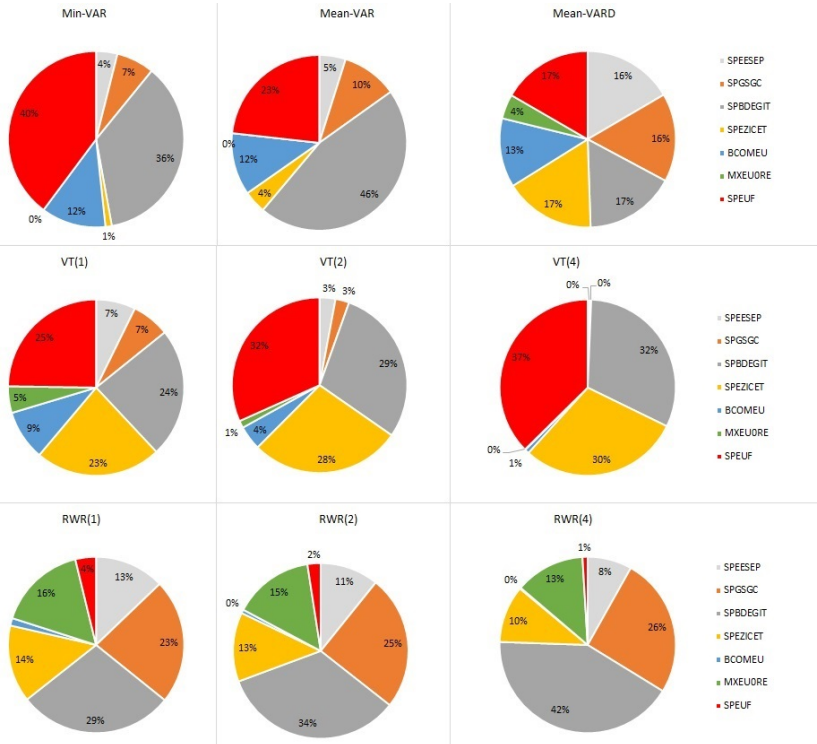
When we compare the results from the Ledoit and Wolf (2008) test for the portfolios built considering the two scenarios with SP EURO 350 in its standard version and its ESG version, they differ from the American case. For the European market, we note that the difference is not significant for any portfolio, even with a significance level of 10%, and that the differences in some cases are negative. However, as the p-values are very high, we can accept for all portfolios that the difference in performance in terms of Sharpe ratios is not statically significant. This means that the investor is not harmed

by replacing the European market stock index with its ESG version. Losses are not statistically significant. Moreover, one can notice from Table 14 that considering all the different performance measures, the results are very close when selecting portfolios using the standard or ESG version of the index.

Observing Figures 4 and 5, we can see that the replacement of the indexes did not bring significant changes in how the weights are assigned to the assets. Especially concerning the SP EURO 350, one can see that the weights are assigned very similarly in the two scenarios.

Finally, the analysis of the European case complements the analysis made with the American market since it shows that such substitution does not harm the investor in both markets.

Figure 5
Average Weights – Europe ESG



Note: The figure shows the average weights assigned to each asset per portfolio in the out-of-sample period.

5. Final considerations

From the first approach adopted in this study, we compared indexes in their traditional and ESG versions for different stock markets in different parts of the world. We noticed that the indexes in their standard and ESG versions have similar performance. Moreover, in terms of Sharpe ratio, if the investor wanted to replace his investments with ESG versions in the stock market, he would not have any losses, and in some cases she may even benefit from this choice. The results show that, comparing the performance of the individual indexes by the Sharpe test, the indexes are not statistically different in their ESG and standard versions. In the two cases where there is a statistically significant difference, the ESG indexes have a superior performance in terms of Sharpe ratio.

Regarding the portfolios built using the indexes in their standard version in ESG, we notice that the returns are also not statistically different in terms of Sharpe ratio. Furthermore, the average weights assigned to the SP 500 and EURO 350 indexes in the portfolios do not change significantly with its replacement by its ESG and Carbon Efficient versions for the American and the ESG version for the European case. Since the replacement of indexes in their standard version by ESG does not affect the performance, the investor concerned about investing in companies that follow the ESG guidelines can replace their standard investments with similar ESG investments without harming their investments' performance.

We have no evidence to say that the substitution would bring gains to the investor, as in Edmans (2012), Khan (2019) and Consolandi et al. (2020). However, our analysis complements other studies such as Halbritter and Dorfleitner (2015) and Naffa and Fain (2022) since it is a different approach that empirically shows that there is no harm to the investor in terms of financial performance when he chooses assets taking into account the spheres environmental, social and governance.

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Table 9
Portfolio selection - USA assets

Portifolios	SP 500 Normal					SP 500 ESG					SP 500 CARBON EFFICIENT				
	Mean	St. Dev.	Sharpe	Sortino	Omega	Mean	St. Dev.	Sharpe	Sortino	Omega	Mean	St. Dev.	Sharpe	Sortino	Omega
NAive	0.60%	0.020	0.29	0.47	2.23	0.60%	0.020	0.30	0.48	2.26	0.60%	0.020	0.29	0.46	2.23
Min-VAR	0.21%	0.008	0.29	0.46	2.25	0.21%	0.008	0.29	0.46	2.25	0.21%	0.008	0.29	0.46	2.25
Mean-VAR	0.29%	0.010	0.30	0.52	2.15	0.30%	0.010	0.30	0.55	2.22	0.29%	0.010	0.29	0.51	2.13
Mean-VARD	0.63%	0.018	0.35	0.62	2.60	0.65%	0.018	0.36	0.65	2.67	0.63%	0.018	0.35	0.61	2.57
VT(1)	0.35%	0.011	0.31	0.46	2.38	0.35%	0.011	0.32	0.47	2.40	0.35%	0.011	0.31	0.46	2.38
VT(2)	0.32%	0.009	0.38	0.72	2.84	0.33%	0.009	0.38	0.73	2.85	0.32%	0.009	0.38	0.72	2.83
VT(4)	0.25%	0.012	0.22	0.29	1.89	0.25%	0.012	0.22	0.29	1.89	0.25%	0.012	0.22	0.29	1.89
RWR(1)	0.69%	0.020	0.35	0.62	2.40	0.71%	0.020	0.35	0.64	2.44	0.53%	0.016	0.32	0.54	2.22
RWR(2)	0.43%	0.013	0.33	0.59	2.26	0.44%	0.013	0.33	0.61	2.29	0.43%	0.013	0.33	0.59	2.25
RWR(4)	0.39%	0.014	0.27	0.51	1.99	0.38%	0.014	0.27	0.51	1.98	0.38%	0.014	0.27	0.51	1.99

Table 10
Sharpe Analysis: Portfolios with Standard SP 500 versus SP 500 ESG

	ESG	Standard	Difference	t-statistics	p_value
Naive	0.2982	0.2928	0.0054	1.9317	0.0534
Min-VAR	0.2867	0.2866	0.0001	1.6248	0.1042
Mean-VAR	0.3039	0.2963	0.0076	0.9420	0.3462
Mean-VARD	0.3640	0.3536	0.0103	1.8838	0.0596
VT(1)	0.3173	0.3135	0.0038	1.8966	0.0579
VT(2)	0.3802	0.3771	0.0031	1.8204	0.0687
VT(4)	0.2160	0.2159	1.9700×10^{-5}	2.1127	0.0346
RWR(1)	0.3543	0.3472	0.0071	1.7463	0.0808
RWR(2)	0.3319	0.3263	0.0055	1.0581	0.2900
RWR(4)	0.2687	0.2708	–0.0021	–0.5231	0.6009

Table 11
Sharpe Analysis: Portfolios with Standard SP 500 versus SP 500 Carbon Efficient

	Carbon Efficient	Standard	Difference	t-statistics	p_value
Naive	0.29210	0.29281	–0.00071	–0.58311	0.55982
Min-VAR	0.28662	0.28661	0.00000	0.90924	0.36322
Mean-VAR	0.29191	0.29631	–0.00440	–1.50099	0.13336
Mean-VARD	0.35098	0.35364	–0.00266	–1.08575	0.27759
VT(1)	0.31273	0.31352	–0.00079	–0.83492	0.40376
VT(2)	0.37646	0.37709	–0.00062	–0.84728	0.39684
VT(4)	0.21593	0.21594	–0.00001	–1.41542	0.15694
RWR(1)	0.32298	0.34718	–0.02420	–1.69250	0.09055
RWR(2)	0.32530	0.32632	–0.00102	–0.50943	0.61045
RWR(4)	0.26963	0.27080	–0.00117	–0.57449	0.56563

Table 12
Descriptive Statistics - Europe assets

	Min	Max	Mean	Median	Skewness	Kurtosis	St.Dev.	VaR	Sharpe
SPE	–14.68%	17.03%	0.31%	0.48%	–0.17	1.13	4.70%	–7.51%	0.07
SPGSGC	–12.15%	12.29%	0.37%	0.05%	0.05	0.08	4.61%	–7.11%	0.08
HFRXGL	–5.88%	2.88%	0.11%	0.33%	–1.12	3.30	1.27%	–2.26%	0.09
SPBDEGIT	–6.51%	5.91%	0.14%	0.23%	–0.35	0.28	2.36%	–3.94%	0.06
SPEZICET	–7.11%	6.27%	0.10%	0.07%	–0.32	0.57	2.43%	–4.06%	0.04
BCOMEU	–14.60%	8.73%	–0.19%	–0.10%	–0.54	1.02	4.08%	–7.39%	–0.05
MXEU0RE	–24.50%	16.62%	0.23%	0.47%	–0.58	2.47	5.56%	–9.48%	0.04
SPEUF	–6.70%	4.86%	–0.12%	–0.24%	–0.30	0.30	2.26%	–4.00%	–0.05

Table 13
Correlation matrix U.S. Europe

	SPE	SPGSGC	HFRXGL	SPBDEGIT	SPEZICET	BCOMEU	MXEU0RE	SPEUF
SPGSGC	0.16							
HFRXGL	0.80	0.12						
SPBDEGIT	0.55	0.42	0.35					
SPEZICET	0.68	0.41	0.49	0.94				
BCOMEU	0.51	0.38	0.50	0.34	0.47			
MXEU0RE	0.83	0.22	0.68	0.58	0.67	0.43		
SPEUF	0.55	0.38	0.30	0.87	0.91	0.47	0.49	
SPEESEP	1.00	0.16	0.78	0.55	0.68	0.50	0.83	0.56

Table 14
Portfolio selection - European assets

Portifolios	EURO-350 Normal					EURO-500 ESG				
	Mean	St. Dev.	Sharpe	Sortino	Omega	Mean	St. Dev.	Sharpe	Sortino	Omega
Naive	0.35%	0.03	0.14	0.21	1.43	0.35%	0.03	0.14	0.21	1.43
Min-VAR	0.21%	0.02	0.10	0.16	1.31	0.21%	0.02	0.11	0.16	1.32
Mean-VAR	0.23%	0.02	0.11	0.17	1.33	0.23%	0.02	0.11	0.17	1.33
Mean-VARD	0.47%	0.03	0.17	0.28	1.55	0.46%	0.03	0.17	0.27	1.55
VT(1)	0.23%	0.02	0.11	0.17	1.33	0.23%	0.02	0.11	0.17	1.33
VT(2)	0.23%	0.02	0.12	0.18	1.34	0.23%	0.02	0.11	0.18	1.34
VT(4)	0.14%	0.02	0.07	0.11	1.20	0.14%	0.02	0.07	0.11	1.20
RWR(1)	0.41%	0.03	0.15	0.25	1.47	0.41%	0.03	0.15	0.25	1.47
RWR(2)	0.36%	0.03	0.13	0.21	1.39	0.35%	0.03	0.13	0.21	1.38
RWR(4)	0.31%	0.03	0.11	0.18	1.33	0.30%	0.03	0.11	0.17	1.32

Table 15
Sharpe Analysis: Portfolios with Standard EURO 350 versus EURO 350 ESG

	ESG	Standard	Difference	t-statistics	p_value
Naive	0.1370	0.1375	−0.0004	−0.2107	0.8332
Min-VAR	0.1054	0.1047	0.0008	0.7024	0.4824
Mean-VAR	0.1110	0.1109	0.0001	0.0464	0.9630
Mean-VARD	0.1701	0.1721	−0.0021	−0.7992	0.4242
VT(1)	0.1108	0.1107	0.0001	0.1012	0.9194
VT(2)	0.1149	0.1151	−0.0002	−0.2599	0.7949
VT(4)	0.0711	0.0710	0.0001	0.8488	0.3960
RWR(1)	0.1479	0.1486	−0.0007	−0.2409	0.8096
RWR(2)	0.1266	0.1288	−0.0022	−0.7770	0.4372
RWR(4)	0.1074	0.1096	−0.0023	−0.7235	0.4694

The impact of ESG momentum in stock prices

Carolina Sverner[†]
Andrea Minardi[‡]
Fernando Tassinari Moraes[*]

Abstract This paper investigates whether ESG (environmental, social and governance) practices impact stock prices. We collected data of the stocks that compose the S&P500 from June 2014 to June 2021. First, we tested the hypothesis that there is a negative relation between stock returns and the ESG rating. We built an ESG factor, following the Fama and French (1993) procedure, with the Sustainalytics ESG score. The results of the two-stage cross-section regressions indicate the existence of an ESG risk premium: we estimated that the portfolio of companies with the worst ESG ratings has a return between 0.20% and 0.29% higher than the portfolio of companies with the best ratings when controlled for other risk factors. Following, we tested the hypothesis that the variation in ESG scores has a significant impact on stock returns. For that, we created an ESG Momentum factor using the same procedure described in Fama and French (1993) and the two-stage cross-sectional regression estimated a return premium between 0.23% and 0.35%—that is, the excess return of a portfolio that is long on the shares with the highest ESG score upgrade, and short on the shares with the highest downgrades. The rating upgrades had a more expressive impact on the returns than the rating downgrades. This is evidence that the improvement in the quality of ESG practices causes an appreciation in the stock prices. However, both results lose significance when we utilize the generalized method of moments (GMM) for estimation.

Keywords: ESG; ESG momentum; Equities risk factor; Sustainability; ESG risk premium.
JEL Code: G11, G12.

1. Introduction

Investment strategies that, besides the traditional risk and return approach, take into account the exposition of companies to Environmental, Social and Governance (ESG) issues have become mainframe. According to Global Sustainable Investment Alliance (GSIA, 2020), more than US$35.5 trillion were invested in funds that claimed to be focused or to address ESG issues: a cumulative growth of 15% in two years, and 55% between 2016 e 2020. ESG investments represent around 36% of the total assets under management in

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[†]Insper, Brazil: carolinass2@al.insper.edu.br
[‡]Insper, Brazil: minardi@insper.edu.br
[*]Insper, Brazil: fernandotm@al.insper.edu.br

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the five markets analyzed by the report.[1] Both ethical reasons and the impact of ESG issues in the long-term performance are behind this behavior. Many financial analysts believe that the winner corporations will be those that treat Environmental, Social and Governance issues as key factors in their strategy.

Several studies propose that the ESG profile is negatively related to idiosyncratic and systematic risks. According to Bénabou and Tirole (2010), the ESG profile of a company can affect its systematic risk because the sustainable practices impact the resilience of the corporation during periods of crises. Factors such as change of regulations, supply chain, technological and reputational risks also affect the idiosyncratic risk (Starks, 2009). Sayani and Kaplan (2020) and Bae et al. (2021) show that a higher ESG score reduces the risk of an abrupt drop in the share price. Dunn et al. (2018) find evidences that the stocks of companies with the lowest MSCI ESG score have a volatility 15% higher and a beta up to 3% higher than the stocks of companies with the highest scores. As ESG characteristics are reflected in the corporate risks, we can assume that they also impact the corporation cost of capital. Therefore, we should expect an appreciation in the share prices of companies that improve its sustainable practices.

Similar to Pástor et al. (2021), we raised the hypothesis that companies with better ESG practices have lower risks, and are preferred by investors who appreciate sustainability. In equilibrium, the shares of companies with better ESG practices are priced higher and consequently have lower expected returns. Therefore, in equilibrium, investors require a return premium to invest in companies with poor ESG practices.

We built the ESG factor, which is linked to the ESG rank of the corporations. Our first hypothesis proposes that the ESG factor is negatively related to the cross-section returns of the stocks.

Most of the studies in the academic literature find a positive relation between the quality of sustainable practices and firm value, but the causal effect of the ESG attributes in firm value can be either positive or negative (Gillan et al., 2021). On the one hand, ESG practices can create shareholder value because they increase future cash flows (ie: consumers pay a premium price on brands that have high reputation on sustainability issues, those companies hire more talented employees which are more productive), or because they reduce the cost of capital either due to the increase in shareholder utility or due to risk reduction. On the other hand, ESG practices can reflect agency problems, and top management can engage on those practices to maximize their utility instead of shareholders' utility (Bénabou and Tirole, 2010). Several ESG practices reduce firm value, because they require heavy investments

[1] Europe, United States, Japan, Canada, Australia and New Zealand.

in CAPEX and incur in high short-term costs and expenses, while it produces uncertain positive returns in the long term (Cornell and Damodaran, 2020). Companies with better operational performance and lower risks are more able to, and have more resources to implement the best environmental, social and governance practices, and therefore, the causal direction is in the opposite direction: higher valuations and better operation performance lead to better ESG performance. Both causal directions predict a positive (negative) relation between stock price (return) and ESG score, and the identification of the causal direction is an econometric concern.

There is little consensus on what is material for each specific industry and region, which results in a lack of convergence in ESG scores of different providers (Berg et al., 2022). Consequently, there are still many inefficiencies in the pricing of environmental, social and governance practices (Pástor et al., 2021).

By logical extension of the first assumption, we can conclude that a change in the ESG profile can also provide useful information on equity valuation. Therefore, our second proposed hypothesis is that if the market appreciates sustainable practices, an improvement in the ESG performance should result in an appreciation on the stock price, while a deterioration in the ESG performance should bring about a stock price reduction. This second hypothesis tests how the stock price reacts to a change in the sustainable practice quality, reducing the identification problem of the first hypothesis.

We built a factor linked to the upward trend of the ESG rank, and called it ESG Momentum (ESGM). Our hypothesis is that the ESG Momentum should result in a significant return premium in the explanation of the cross-section returns, because as sustainable practices improve, there is a reduction in the ESG risk, and consequently an appreciation in the stock price.

We used the relative position in the ESG scores (ESG rank) of Sustainatytics Morningstar as a proxy for ESG profile, and collected data of the stocks that compose the S& P 500 index to test both hypotheses during the period between June 2014 and June 2020.

This article brings two main contributions. Firstly, it addresses the relation between the current ESG profile of a company and its return, without investigating the direction of the causality. The second is related to the explanation power of the improvements in the quality of ESG practices on the stock returns. Both results are in accordance to our proposed hypotheses. We find evidence, yet weak, of a premium for poor ESG practices, that is, a negative relation between stock return and ESG score, and a premium for the ESGM factor, indicating that improvement in the quality of the ESG practices result in the stock price appreciation.

Evidences that share price reacts positively to ESG practices may motivate more players in the financial market to incorporate ESG momentum in their investment decision, creates incentives for the launch of funds focused on buying shares of companies improving ESG practices, and also support board members and top management in defending the implementation of corporate sustainability initiatives.

2. Theoretical framework and hypotheses formulation

Halbritter and Dorfleitner (2015), Nagy and Giese (2018), Dunn et al. (2018), Giese et al. (2019a,b), Lee et al. (2021), Pástor et al. (2021) are some of the academic studies that investigate the relation between ESG ratings, risk metrics and returns. There is a lack of consensus in the literature, and this is expected, since the disclosure of sustainable practices of different companies and countries are heterogeneous (Baldini et al., 2018), ESG scores of different providers often diverge (Berg et al., 2022), and there is a broad spectrum about what is considered as an ESG investment.

Initially, social responsible investments (SRI) were limited to *negative screening*, that is, to exclude from the investment portfolio securities of companies with low ESG classification, or even whole sectors like tobacco, weapons and cigars, regardless of the specific sustainability conduct of a company. According Kotsantonis et al. (2016), this approach of ESG investing fails in capturing the value added by sustainable practices.

However, even among studies which consider other ESG investment strategies, as for instance positive screening (search for the companies with the best ESG score in relation to the peers), or ESG integration (systematic integration of ESG issues in the analysis and investment decisions,[2]) there is divergence in the findings.

Dunn et al. (2018) find evidences that stocks with lower ESG scores have higher total, specific and systematic risks. They also found that the ESG classification can predict future risks up to five years. Sayani and Kaplan (2020), and Bae et al. (2021) showed that, once controlled for other risk factors, companies with the highest MSCI ESG scores have historically lower frequency of tail risk, that is, sudden drops in stock prices.

Hong and Kacperczyk (2009) found evidences of a return premium in the "sin" stocks (alcohol, tobacco, and gaming). According to the authors, some investors, especially those that are norm constrained, like pension funds, abstain from investing in stocks that promote vice. A lower demand for those securities imply in lower stock prices, and consequently higher future re-

[2] According to PRI (Principle for Responsible Investment)

turns. Kotsantonis et al. (2016) propose that investors that are attracted by a company's sustainable practices may accept lower returns, and as a consequence, reduce its cost of capital. Both articles are in accordance to Pástor et al. (2021), which propose that in equilibrium, assets with better sustainable practices have lower expected returns than assets with poor practices, and this is due either to the investors preference for holding sustainable securities, or for a recognition that those assets have lower risk.

Halbritter and Dorfleitner (2015) observed that the explanation power of ESG score in stock returns is reduced along time. They built a portfolio long in the shares of companies with the highest ESG score and short in the shares of companies with the lowest ESG scores, and found a positive alpha in the period between 1991 and 2001. They observed a drop in the alpha after this period, and after 2012 the alpha found became not significantly different from zero. As more investors value good sustainable practices, the share price of companies with better ESG profiles rises, and their expected rate of return become lower than those of companies with poor practices.

Accordingly, we raised the hypothesis that companies with higher ESG scores should have lower returns than companies with lower scores. That is, we propose that there is a premium for corporate sustainability—investors require an excess return to invest in companies with the worst sustainable practices.

H_1: A factor linked to ESG has a negative relationship with the cross-section returns.

Materiality is a relevant issue regarding the impact of sustainable practices on firm value. A specific ESG topic may be very relevant to a certain industry (material factor), and peripheric to another one (immaterial factor). Khan et al. (2016) classified sustainable issues reported by corporations as material and immaterial according to the industry materiality map of the Sustainability Accounting Standard Boards (SASB), and built a material (immaterial) firm specific rating. Results indicated that firms with high residual changes on material issues outperformed firms with low residual changes on the same issues. However, firms with high residual chances on immaterial sustainability issues do not outperform firms with low residual changes on these topics.

The disclosure of sustainability practices and the concept of what is material across different sectors, companies and regions are heterogenous (Baldini et al., 2018). Berg et al. (2022) observed that the ESG ratings of the six main providers disagree substantially– the mean correlation of the ESG scores assigned by different providers is only 0.54. The main sources of divergence are the sets of attributes they use, different indicators used to measure each

attribute and the weight divergence. This lack of standardization makes it difficult to evaluate the ESG performance of companies, funds and portfolios. It also creates mixed signals and decreases the incentive of companies to improve their sustainable practices, and disperses the effect of ESG performance on investors' preference and asset prices. It also represents a challenge for academic research, since the choice of utilizing the rating of one provider versus another may change the results and conclusions. Halbritter and Dorfleitner (2015) did not find consistent results in terms of return predictability when using ESG classifications of different providers.

Nagy and Giese (2018) argues that the analysis of the change in ESG score, that is, the ESG momentum, is a more useful approach to understand how the market prices sustainability practices than using static scores, since it provides evidences of the direction of the causality. The authors concluded that the upgrade of the ESG score leads to an appreciation of the equity value, while the downgrade of the ESG score leads to a depreciation of the stock price. They also observe that the impact in valuation is higher for companies with ESG scores in the intermediate range rather than for companies with extreme scores.

Giese et al. (2019b) point that the assignment of ESG ratings to companies is relatively recent, and the time series of scores are short, resulting in a lower statistic confidence level when compared to other usual risk factors. Given the amount of data and the short time horizon of the available data, the impact of changes in the ESG score (ESG Momentum) is more immediate and measurable than the impact of the static score on ESG corporate performance. The authors also observe that ESG momentum had a higher correlation to ESG performance, and it was the most consistent variable across time when comparing to other ESG dimensions.

Based on this discussion, we raised a second hypothesis: an improvement on ESG performance leads to equity value appreciation, and consequently, to abnormal return to investors. The variation of the ESG classification is related to a change in the firm risk, and generates abnormal returns.

H_2: A risk factor linked to the variation of ESG score (ESG Momentum) has a positive relationship to the cross-section returns.

3. Data base and methodology

We collected monthly closing price data of the stocks that compose the S& P500 index during the period between June 2014 and June 2021 in Bloomberg. We excluded stocks with missing price information, and which did not have an ESG classification by Sustainalytics. Our final sample was comprised

of 451 companies. The reason why we chose the S& P index lies on a high percentage of stocks that are ESG ranked by Sustainalytics, and as well receive good coverage by financial analysts, with prices that reflect current information.

We used the relative ESG score (ESG rank) as a proxy for ESG firm profile. We collected data of the ESG score of Sustainalytics of Morningstar in Bloomberg, during the period between June 2014 and June 2021. Unfortunately, we did not have access to data of different main providers to check if our results hold to other ESG ratings' datasets. We had access only to the time series of Sustainalytics ESG rank, and not to time series of absolute scores. Although the use of ESG rank reduces the data sensitiveness to outliers and problems due to kurtosis and skewness in the series (Baldini et al., 2018), we recognize that it would be advisable to analyze as well the impact of changes of absolute scores on stock returns, and that the impossibility of doing so is a limitation to our analysis.

The aggregate ESG score of Sustainalytics consolidates the level of preparation, disclosure and involvement in controversies of the company in all three pillars: E, S and G. ESG rank is a classification of a company in the environmental, social and governance pillars of a company relatively to its peers in the industrial sector. The top 1%, corresponds to the percentile 99%, and the bottom 1% to the percentile 1%. Higher scores in ESG rank represent less risky ESG profile. Therefore, score upgrades represent a positive momentum, and score downgrade a negative momentum.

In order to build the ESG Momentum (ESGM), we firstly estimated the annual variation of the company ESG score. For example, the ESG momentum of a certain stock in June 2019 will be measured as the change in the ESG rank of this stock between June 2018 and June 2019. We used annual variation because we did not observe significant score variation in shorter periods. As we need 12-month lag to estimate the score variation in year t, the ESG momentum series start in June 2015 and ends in June 2021, summing up to 72 time series observations for each stock.

In June of each year t, from 2015 to 2021, we ranked stocks in descending order according to their ESG Momentum. Based on this ranking, we allocated the stocks in three portfolios: high (H) – the tercile of the stocks with the highest ESG score, medium (M) – the tercile of stocks with the intermediary ESG scores, and low (L) – the tercile of stocks with the bottom ESG scores.

In order to avoid the influence of company size on ESG-related factors, we control the factors for this characteristic. For this, in June of each year t, from 2015 to 2021, all shares in the database were classified by size (price times number of shares). The median size was then used to divide the database into

two groups, one of small companies and the other of big companies called "small" and "big" (S and B respectively).

From the intersections of the two size groups with the three ESG momentum groups, six equally weighted portfolios were constructed: Small Low (S|L), Small Medium (S|M), Small High (S|H), Big Low (B|L), Big Medium (B|M), Big High (B|H). The B|H portfolio, for example, contains the stocks of high ESG momentum (H) among the stocks of the large size group (B).

The monthly returns of the six portfolios were calculated from July of year t to June of $t+1$, and the portfolios were rebalanced in June of $t+1$. The choice of annual rebalancing was due to the findings of Nagy and Giese (2018), who pointed out that changes in the ESG characteristics of a company led to more expressive variations in the price of shares in a time horizon of one year, compared to shorter and longer periods.

The return of the high, medium and low Momentum ESG portfolios is the simple average between the returns of the big and small portfolios of each of the three momentum groups, as presented in equations (1), (2) and (3). The ESGM factor, intended to capture the effect on the returns resulting from the variation of the ESG profile, is the monthly difference between the portfolios of high ESG momentum (H) and low ESG momentum (L), as shown in equation (4). Thus, the difference between the two returns must be independent of the size factor, evidencing instead the different return behaviors of high and low ESGM companies

$$R(\text{High}) = \frac{R(\text{Small}|\text{High}) + R(\text{Big}|\text{High})}{2} \tag{1}$$

$$R(\text{Medium}) = \frac{R(\text{Small}|\text{Medium}) + R(\text{Big}|\text{Medium})}{2} \tag{2}$$

$$R(\text{Low}) = \frac{R(\text{Small}|\text{Low}) + R(\text{Big}|\text{Low})}{2} \tag{3}$$

$$\text{Risk Factor} = R(\text{High}) - R(\text{Low}) \tag{4}$$

The ESG factor was constructed in the same way as the ESGM factor, using, however, the ESG rank score instead of its annual variation to define the high (H), medium (M) and low (L) groups.

Table 1 presents the median and cut-off point of the 1st and 2nd tercile of ESG momentum for small (S) and large (B) companies in each year of the sample. We can observe that in some years the medians move away from zero, indicating that there are more score upgrades (years with a positive median) or score downgrades (years with a negative median). In addition, the dispersion of ESG momentum for smaller companies was higher than for larger

Table 1
Distribution of ESG Moments

	SMALL			BIG		
	Median	Min 1st tercile (High)	Min 2nd tercile (Low)	Median	Min 1st tercile (High)	Min 2nd tercile (Low)
2015-06-30	0.64%	9.03%	−5.95%	0.48%	6.06%	−3.61%
2016-06-30	−0.10%	6.70%	−6.75%	−1.66%	2.75%	−6.76%
2017-06-30	−0.79%	6.21%	−9.10%	−0.13%	4.44%	−7.79%
2018-06-29	3.74%	13.90%	−0.85%	3.55%	12.00%	−0.43%
2019-06-28	1.68%	8.74%	−5.83%	0.60%	7.26%	−6.53%
2020-06-30	1.05%	9.52%	−6.63%	−0.60%	4.49%	−6.62%
2021-06-30	−2.05%	5.20%	−7.59%	−1.84%	3.90%	−7.00%

Table 2
Distribution of ESG scores

	SMALL			BIG		
	Median	Min 1st tercile (High)	Min 2nd tercile (Low)	Median	Min 1st tercile (High)	Min 2nd tercile (Low)
2015-06-30	48.80	60.10	34.60	61.10	71.80	45.30
2016-06-30	48.70	61.70	35.80	58.90	70.70	45.60
2017-06-30	47.50	57.50	36.30	58.10	68.70	43.90
2018-06-29	51.70	63.20	36.20	61.90	73.00	50.50
2019-06-28	50	65.10	36.70	61.90	72.50	49.30
2020-06-30	51.40	65.10	37.30	61.70	73.40	50.40
2021-06-30	51.90	63.40	40.40	59.90	74.10	45.80

companies, so that the tercile's cut-off points were more distant from each other for smaller companies.

Table 2 presents the same information as the previous table, but referring to ESG rank scores. We were able to observe that the largest 50% companies in the sample have higher ESG scores than the smallest 50%, confirming our choice to control ESG and ESGM factors for size.

Figures 1 to 4 shows the cumulative return of each of the 12 portfolios (6 ESGM portfolios and 6 ESG portfolios) during the analyzed period.

Tables 3 and 4 present the descriptive analysis of the returns of the 6 ESGM and 6 ESG portfolios, respectively. We can verify that, among the portfolios built based on ESG momentum, the ones that produced the best annualized cumulative returns were the high-momentum ones, and the worst annualized cumulative returns were obtained by purchasing the average-momentum portfolios. Among the portfolios built on ESG scores, the ones that produced the best annualized cumulative returns were those with medium scores, followed by high grades and finally low grades. However, it was not possible to observe statistical significance in the t-tests for the comparison between the

Figure 1
Cumulative return of ESG Momentum portfolios of small companies (S|H, S|M and S|L)

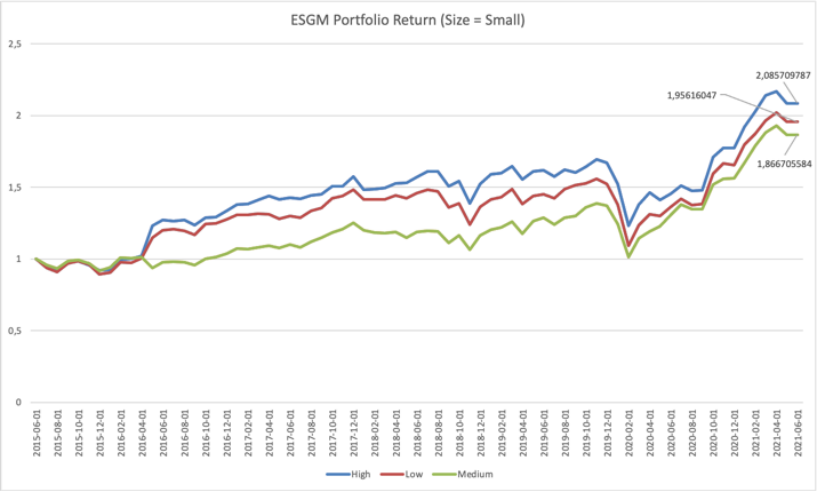


Figure 2
Cumulative return of ESG Momentum portfolios of big companies (B/H, B/M and B/L)

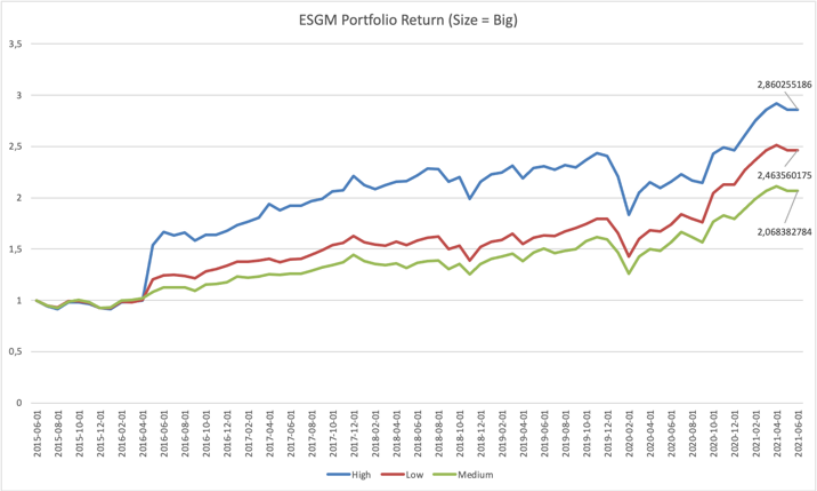


Figure 3
Cumulative return of ESG portfolios of small companies (S|H, S|M e S|L)

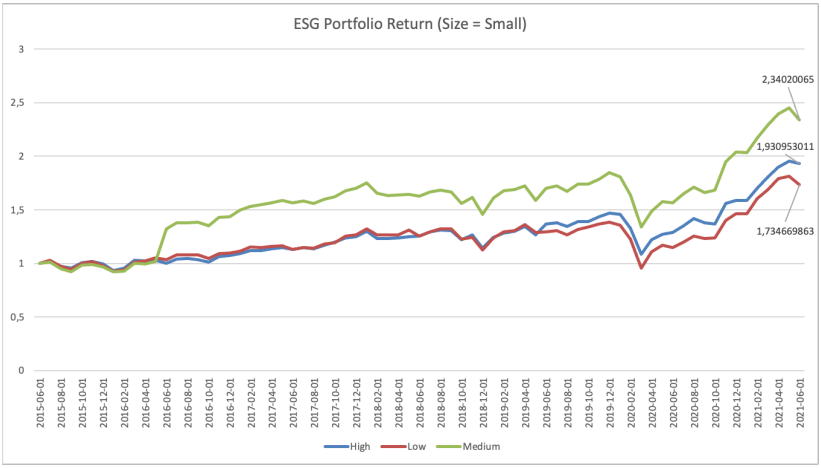


Figure 4
Cumulative return of ESG portfolios of big companies (B|H, B|M e B|L)

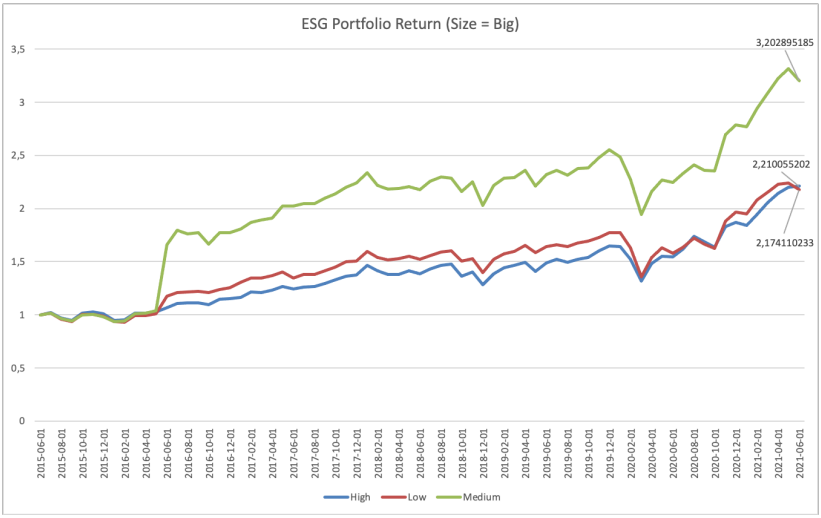


Table 3
Annualized Cumulative Return of 6 portfolios formed by ESGM and size

			ESGM						
			High	Medium	Low		Difference		
			1	2	3		(1 – 3)	(1 – 2)	(2 – 3)
SIZE	Big		19.52%	13.08%	16.68%		3.08%	5.99%	–3.62%
		Sd	0.27	0.16	0.17	Sd	0.15	0.20	0.07
						p-value*	0.76	0.56	0.72
	Small		13.33%	11.46%	12.14%		0.91%	1.22%	–1.49%
		Sd	0.19	0.17	0.19	Sd	0.05	0.13	0.10
						p-value*	0.93	0.85	0.93
			5.99%	0.94%	3.64%				
	Difference	Sd	0.14	0.07	0.05				
		p-value*	0.62	0.90	0.72				

Note: * – p-value for t-test for two populations.

Table 4
Annualized Cumulative Return of 6 portfolios formed by ESG and size

			ESG						
			High	Medium	Low		Difference		
			1	2	3		(1 – 3)	(1 – 2)	(2 – 3)
SIZE	Big		14.13%	21.41%	13.82%		–0.28%	–12.16 %	7.29%
		Sd	0.15	0.29	0.17	Sd	0.07	0.24	0.19
						p-value*	0.99	0.53	0.54
	Small		11.59%	15.22%	9.61%		1.28%	–5.08%	4.64%
		Sd	0.16	0.21	0.18	Sd	0.06	0.14	0.14
						p-value*	0.89	0.72	0.64
			1.94%	6.04%	3.20%				
	Difference	Sd	0.05	0.13	0.09				
		p-value*	0.82	0.65	0.73				

Note: * – p-value for t-test for two populations.

different portfolios. This result is probably due to the restricted size of the database, which ends up converting into lower statistical confidence levels.

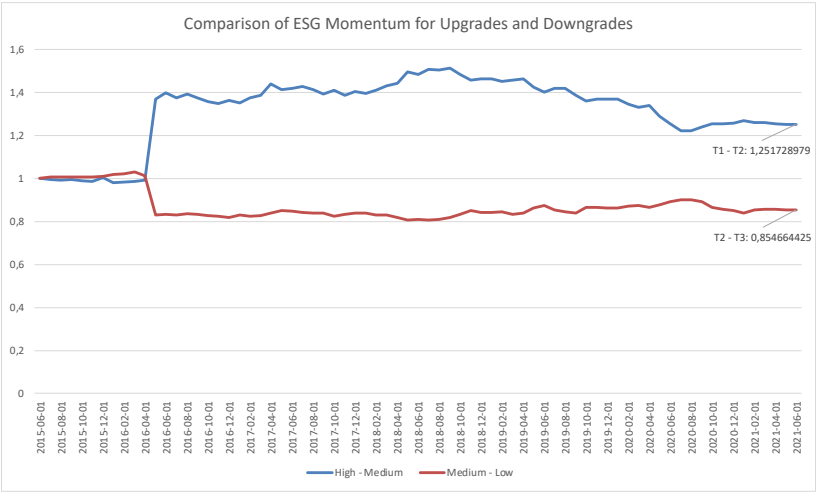
Following the procedure adopted by Nagy and Giese (2018) to assess the divergence of the impact of upgrades and downgrades of ESG scores on equity return, we measured the return due to upgrades as the difference between the portfolio high (H) and medium (M) ESG Momentum, while the return due to downgrades was calculated as the difference between the medium (M) and low (L) portfolio of ESG Momentum, according to equations (5) and (6).

$$R(\text{Upgrade}) = R(\text{High}) - R(\text{Medium}) \tag{5}$$

$$R(\text{Downgrade}) = R(\text{Medium}) - R(\text{Low}) \tag{6}$$

We observe in Table 3 that there is an apparent asymmetry in the magnitude of the variation of returns, since upgrades ("Difference 1-2") have a

Figure 5
Comparison of cumulative return performance due to ESG score upgrades and downgrades



stronger performance than downgrades ("Difference 2-3") in both large and small companies. Figure 5 displays this result graphically.

We controlled the return for four other risk factors: Mkt (market), SMB (small minus big), HML (high minus low) and QMJ (quality minus junk). We collected monthly time series data of Mkt, SMB and HML returns on Kenneth Fama[3] website. The monthly return data of QMJ was collected on AQR[4] website. The definition of the four factors are as follows:

Mkt is the "market" factor, measured as the difference between the market portfolio return (capitalization weighted) and the risk-free rate return (1-month US treasury bond).

SMB is the "size" factor, measured as the difference between the return on a diversified portfolio of small stocks and one of big stocks.

HML is the "value" factor, measured as the difference between the return on a diversified portfolio of high and low Book to Market value (book value over market value).

QMJ is the "quality" factor, measured through the difference between the

[3] https://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html

[4] https://www.aqr.com/Insights/Datasets/Quality-Minus-Junk-Factors-Monthly

return on a diversified portfolio of high and low quality stocks (Asness et al 2019). The quality is measured as a function of the company's profitability, security and growth. The quality factor was included in the model to control for the correlation between ESG and quality.

To estimate risk factor premiums, we used two methodologies: 1) two-step regression and; 2) generalized method of moments (GMM). According to Goyal (2012), the two-step regression consists of, firstly, estimating a time series regression in which, for each asset, the beta vector ($\boldsymbol{\beta}_i$) is estimated in relation to the risk factors. The second step is to estimate a cross-sectional regression in which the estimated betas from the first step are used to estimate the vector of the risk premium of the factors. Equations (7) and (8) describe the first and second stage respectively:

$$R_{i,t} = \alpha_i + \boldsymbol{\beta}_i \boldsymbol{F}_t + \varepsilon_{i,t} \tag{7}$$

$$\bar{R}_i = a + \widehat{\boldsymbol{\beta}}_i \boldsymbol{\lambda} + e_i, \tag{8}$$

Where $R_{i,t}$ corresponds to the monthly excess return of asset i in period t, $\boldsymbol{F}_t$ is the vector of risk factors, $\bar{R}_i$ is the average monthly excess return of asset i in the time period we analyzed, and $\boldsymbol{\lambda}$ is the vector of risk premium for the factors.

The GMM is a more robust method to estimate risk premium returns than the two-step regression, because it estimates equations (7) and (8) simultaneously, addressing the problems of autocorrelation and heteroscedasticity of residuals. In addition, the methodology avoids possible standard error problems that can arise with two-step regression.[5]

Considering equations (7) and (8), by construction, we have that $E(\varepsilon_{i,t}) = 0$ and$E(\varepsilon_{i,t}) = 0$,, and the GMM conditions are given by (9).

$$g_t(a, \boldsymbol{\beta}, \boldsymbol{\alpha}, \boldsymbol{\lambda}) = \begin{bmatrix} (\boldsymbol{R}_t - \boldsymbol{\alpha} - \boldsymbol{\beta}\boldsymbol{F}_t) \\ (\boldsymbol{r}_t - \boldsymbol{\alpha} - \boldsymbol{\beta}\boldsymbol{F}_t) \otimes \boldsymbol{F}_t \\ (\mathbf{1}, \boldsymbol{\beta}')(\boldsymbol{R}_t - a - \boldsymbol{\beta}\boldsymbol{\lambda}) \end{bmatrix} \tag{9}$$

where $\boldsymbol{R}_t$ corresponds to the vector of monthly excess return of all stocks in the sample, $\otimes$ is the operator of the Kroecker product, and $\mathbf{1}$ is the unit vector. The parameters are estimated according to (10),

$$\left\{\widehat{a}, \widehat{\boldsymbol{\beta}}, \widehat{\boldsymbol{\alpha}}, \widehat{\boldsymbol{\lambda}}\right\} = \text{argmin}_{\{a,\beta,\alpha,\lambda\}} \sum_{t=1}^{T} [g_t(a, \boldsymbol{\beta}, \boldsymbol{\alpha}, \boldsymbol{\lambda})]' \boldsymbol{I} \sum_{t=1}^{T} [g_t(a, \boldsymbol{\beta}, \boldsymbol{\alpha}, \boldsymbol{\lambda})], \tag{10}$$

[5] See Shanken (1992) for more details about the standard error estimation problem in equations (7) and (8).

Table 5
Descriptive statistics of risk factors

	annualized		
Risk Factor	av. return	st. deviation	Sharpe Ratio
ESG	0.01	0.05	0.11
ESGM	0.02	0.09	0.23
Mkt	0.15	0.16	0.94
SMB	0.01	0.09	0.06
HML	–0.06	0.13	–0.49
QMJ	0.03	0.09	0.34

and the R^2 is calculated according to (11) since our focus is on the accuracy of the factor risk premia.

$$R^2 = 1 - \frac{\sum_{i=1}^{N} \left(\bar{R}_i - \widehat{a} - \widehat{\boldsymbol{\beta}}_i \widehat{\boldsymbol{\lambda}}\right)^2}{\sum_{i=1}^{N} \left(\bar{R}_i\right)^2}. \tag{11}$$

4. Discussion of the results

Table 5 contains descriptive statistics of the risk factors. It can be seen that the Sharpe ratio of the ESGM factor is positive, indicating that the variation of ESG scores is directly related to returns (i.e., the greater the ESG momentum of a company, the greater its returns). These results corroborate with Nagy and Giese (2018), who associate increases in a company's ESG score (positive ESG moment) with equity value appreciation.

Table 6 presents the correlation matrix between the factors used, in which we can verify that the ESGM factor controlled by size has a low correlation with the other factors, including the factor linked to quality. The ESG factor, in turn, has a slightly higher correlation with the other factors.

In Figure 6, it is possible to visualize the accumulated return of all the factors considered. We can see that the ESGM factor has the third best accumulated positive performance, behind the market and quality factors. In module, however, the accumulated return of the factor lags behind the other factors already established in the literature, with the exception of the factor linked to size, which had a lower performance than the ESG Momentum factor.

We ran four time series regressions (TS1 to TS4) of the ESG and ESGM factors. Table 7 indicates the factors used as dependent and explanatory in

Table 6
Correlation matrix of risk factors

	ESG	ESGM	Miot	SMB	HML	QMJ
ESG	1	−0.48	−0.11	−0.15	−0.13	0.22
ESGM	−0.48	1	−0.11	−0.08	−0.09	0.08
Miot	−0.11	−0.11	1	0.35	0.18	−0.50
SMB	−0.15	−0.08	0.35	1	0.22	−0.59
HML	−0.13	−0.09	0.18	0.22	1	0.02
QMJ	0.22	0.08	−0.50	−0.59	0.02	1

Figure 6
Cumulative return of risk factors

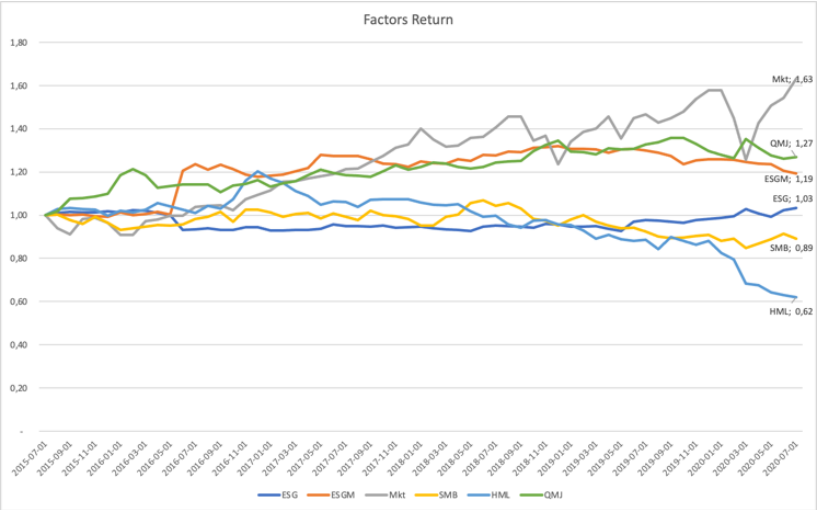


Table 7
Dependent and explanatory factors in different time series regression models

Modelo	Rt	Ft
TS1	ESG	Mkt + SMB + HML
TS2	ESG	Mkt + SMB + HML + QMJ
TS3	ESGM	Mkt + SMB + HML
TS4	ESGM	Mkt + SMB + HML + QMJ

each time series regression (defined by equation (12)).

$$R_{i,t} = \alpha_i + \boldsymbol{\beta}_i \boldsymbol{F}_t + \varepsilon_{i,t}. \tag{12}$$

The results of these regressions are shown in Table 8. Both the ESG factor and the ESGM could not be explained by any of the other four factors, since all the four regressions presented an adjusted R^2 close to zero and statistical insignificance. This result indicates possible new information brought by the ESG and ESGM factors that are not contained in the other factors. However, none of the time series regressions showed a significant intercept.

Table 9 contains the result of the two-step cross-section regression (equations (7) and (8)) using as dependent variable the excess return of the 451 stocks in the sample. The regressions showed a very high adjusted R^2, approximately 90%, demonstrating the high explanatory power of these factors on cross-section returns. The risk premiums of all the factors were significant in all regressions. However, we observe a significant intercept in all the models, indicating the persistence of idiosyncratic risk not explained by the factors, and therefore our factors were insufficient to explain the stock returns in its entirety.

The ESG factor showed consistently negative and significant lambda between −0.2% and −0.28%. This result corroborates our hypothesis H_1, according to which there is a significant risk premium related to ESG scores: higher (lower) sustainability reduces (increases) stock returns between 0.2% and 0.28%. This result is consistent with the equilibrium advocated by Pástor et al. (2021), which establishes that the higher the ESG rating of a company, the lower the return required by investors for its shares.

The ESGM factor showed consistently positive and significant lambda, between 0.23% and 0.32%. This result validates our hypothesis H_2, according to which there is a risk premium linked to the variation of the ESG scores This is evidence that share prices adjust positively to ESG score upgrades, resulting in abnormal gains for the investor, and it is in accordance to Nagy and Giese (2018) and Giese et al. (2019a).

Table 8
Time series regressions of factors ESG and ESGM on the other four risk factors

Time series regression		TS1	TS2	TS3	TS4
Coefficient		ESG	ESG	ESGM	ESGM
Intercept	Estimate	0.00	−0.00	0.00	0.00
	std. error	0.00	0.00	0.00	0.00
	t value	0.36	−0.14	0.74	0.63
	p-value	0.72	0.89	0.46	0.53
Mkt	Estimate	−0.02	0.01	−0.05	−0.04
	std. error	0.04	0.05	0.08	0.09
	t value	−0.40	0.27	−0.64	−0.49
	p-value	0.69	0.79	0.52	0.62
SMB	Estimate	−0.06	0.01	−0.03	−0.01
	std. error	0.07	0.09	0.13	0.16
	t value	−0.83	0.15	−0.26	−0.09
	p-value	0.41	0.88	0.80	0.93
HLM	Estimate	−0.04	−0.06	−0.05	−0.06
	std. error	0.05	0.05	0.09	0.10
	t value	−0.78	−1.14	−0.58	−0.61
	p-value	0.44	0.26	0.57	0.55
QMJ	Estimate		0.15		0.04
	std. error		0.10		0.18
	t value		1.53		0.22
	p-value		0.13		0.83
Adjusted-R2		−0.01	0.01	−0.03	−0.04

Note: ‡– p-value < 0.01; †– p-value < 0.05; * – p-value < 0.1.

Table 10 shows the results of the two-stage cross-section regression according to equations (7) and (8), but using as dependent variable an aggregate of 150 portfolios constructed from the factors size, value, profitability and investment, available on Kenneth French[6] website. These portfolios represent 6 sets of 25 portfolios formed from the two-by-two intersection of 5 portfolios created from each factor. Both ESG and ESGM factors presented significant risk premiums. However, the explanatory power of the models was reduced to approximately 30%. The magnitude of the ESG factor premium was similar to the test applied to individual stocks: between 0.25% and 0.29%. However, the magnitude of the ESGM factor premium: between 0.78% and 0.8% was more than double the previous test.

Table 11 shows the results for two-stage cross-section regression according to equations (7) and (8), using as the dependent variable 96 portfolios available on Kenneth French's website as the response variable. These portfolios represent 3 sets of 32 portfolios formed from the three-to-three intersection of 2 categories of size, 4 of value, 4 of profitability and 4 of investment. The lambdas of the ESG and ESGM factors were not significant in any of the models. The only factors with a statistically risk premium different from zero were size (SMB), value (HML) and investment (CMA), which managed to explain up to 50% of the returns.

Tables 12, 13 and 14 show the results of the tests in Tables 9, 10 and 11 respectively, but using the GMM method described in equations (9), (10) and (11).[7] We can verify that when we eliminate the bias in the estimation of the standard errors of the coefficients of the cross-section regression, most of the risk premiums lose their statistical significance.

In Table 12 we see that the only factor that presented a significant risk premium in all the models was the value factor (HML). With the exception of the M2 model in the table, the intercepts remained significant, indicating the existence of additional returns not explained by the models. Despite being statistically insignificant, we observe a positive lambda for ESGM factor in all the models.

In Tables 13 and 14, we see that none of the factors considered presented a significant risk premium and, with the exception of one model, all presented intercepts statistically different from zero, once again reiterating the insufficiency of the models in explaining the excess return of the portfolios.

[6]https://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html.

[7]It is important to notice that the GMM described by equations (9) and (10) is exactly identified, so the Sargan-Hansen test is not applied in this case. Furthermore, instrumental variables are not employed in this case since the GMM is used only to estimate equations (7) and (8) simultaneously and to account for autocorrelation and heteroscedasticity of residuals.

Table 9
Two-stage cross-sectional regression, where the dependent variable is the excess return of the 451 stocks

2-step cross-sectional

Coefficient		M1	M2	M3	M4	M5	M6
Intercept	Estimate	0.0087	0.0069	0.0080	0.0068	0.0085	0.0071
	std. error	0.0012	0.0012	0.0012	0.0012	0.0012	0.0012
	t value	7.5160	5.9560	6.7680	5.6530	7.2260	6.1090
	p-value	0.0000‡	0.0000‡	0.0000‡	0.0000‡	0.0000‡	0.0000‡
Mkt	Estimate	0.0060	0.0078	0.0069	0.0081	0.0062	0.0075
	std. error	0.0011	0.0011	0.0011	0.0012	0.0012	0.0011
	t value	5.3850	6.8940	6.0290	6.9880	5.3590	6.6030
	p-value	0.0000‡	0.0000‡	0.0000‡	0.0000‡	0.0000‡	0.0000‡
SMB	Estimate	0.0040	0.0048	0.0042	0.0049	0.0040	0.0050
	std. error	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008
	t value	4.8490	5.9050	4.9680	5.7970	4.8330	6.0530
	p-value	0.0000‡	0.0000‡	0.0000‡	0.0000‡	0.0000‡	0.0000‡
HLM	Estimate	−0.0117	−0.0115	−0.0115	−0.0114	−0.0117	−0.0116
	std. error	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008
	t value	−14.5830	−14.7410	−14.0870	−14.1650	−14.4280	−14.8630
	p-value	0.0000‡	0.0000‡	0.0000‡	0.0000‡	0.0000‡	0.0000‡
QMJ	Estimate		−0.0023		−0.0026		−0.0022
	std. error		0.0007		0.0007		0.0007
	t value		−3.2790		−3.5550		−3.0490
	p-value		0.0011‡		0.0004‡		0.0024‡
ESG	Estimate	−0.0026	−0.0020			−0.0024	−0.0028
	std. error	0.0001	0.0001			0.0005	0.0005
	t value	−33.6170	−13.8620			−4.6800	−5.6390
	p-value	0.0000‡	0.0000‡			0.0000‡	0.0000‡
ESGM	Estimate			0.0032	0.0031	0.0028	0.0023
	std. error			0.0001	0.0001	0.0002	0.0002
	t value			36.7430	32.4660	18.2260	13.4880
	p-value			0.0000‡	0.0000‡	0.0000‡	0.0000‡
Adjusted-R2		0.9080	0.9140	0.9060	0.9100	0.9080	0.9140

Note: ‡– p-value < 0.01; †– p-value < 0.05; * – p-value < 0.1.

Table 10
Two-stage cross-sectional regression with 150 Fama and French portfolios as the response variable

2-step cross-sectional – FF 150 portfolios (6 × 25)

Coefficient		M1	M2	M3	M4	M5	M6
Intercept	Estimate	0.0169	0.0171	0.0160	0.0163	0.0163	0.0165
	std. error	0.0017	0.0017	0.0015	0.0016	0.0017	0.0017
	t value	10.2210	10.0070	10.3380	9.9910	9.8560	9.6930
	p-value	0.0000‡	0.0000‡	0.0000‡	0.0000‡	0.0000‡	0.0000‡
Mkt	Estimate	−0.0049	−0.0050	−0.0039	−0.0041	−0.0043	−0.0044
	std. error	0.0016	0.0016	0.0014	0.0015	0.0016	0.0016
	t value	−3.1060	−3.1280	−2.6850	−2.7590	−2.6800	−2.7220
	p-value	0.0023‡	0.0021‡	0.0081‡	0.0065‡	0.0082‡	0.0073‡
SMB	Estimate	0.0025	0.0022	0.0031	0.0027	0.0029	0.0027
	std. error	0.0005	0.0007	0.0005	0.0007	0.0005	0.0007
	t value	5.2440	3.2500	6.3940	3.8350	5.7160	3.7710
	p-value	0.0000‡	0.0014‡	0.0000‡	0.0002‡	0.0000‡	0.0002‡
HLM	Estimate	−0.0018	−0.0016	−0.0024	−0.0023	−0.0024	−0.0023
	std. error	0.0006	0.0007	0.0007	0.0007	0.0007	0.0007
	t value	−2.7570	−2.3980	−3.4660	−3.0720	−3.4430	−3.0830
	p-value	0.0066‡	0.0178†	0.0007‡	0.0025‡	0.0008‡	0.0025‡
QMJ	Estimate		−0.0013		−0.0013		−0.0013
	std. error		0.0007		0.0007		0.0007
	t value		−1.8910		−1.8880		−1.9010
	p-value		0.0606*		0.0611*		0.0593*
ESG	Estimate	−0.0026	−0.0025			−0.0029	−0.0028
	S Error	0.0015	0.0015			0.0014	0.0015
	t value	−1.8130	−1.6940			−2.0210	−1.8860
	p-value	0.0720*	0.0924*			0.0451†	0.0613*
ESGM	Estimate			0.0080	0.0078	0.0080	0.0078
	S Error			0.0028	0.0028	0.0028	0.0029
	t value			2.8200	2.7410	2.8250	2.7500
	p-value			0.0055‡	0.0069‡	0.0054‡	0.0067‡
Adjusted-R2		0.2260	0.2220	0.2480	0.2460	0.2450	0.2410

Note: ‡– p-value < 0.01; †– p-value < 0.05; * – p-value < 0.1.

Table 11
Two-stage cross-sectional regression with 96 Fama and French portfolios as the response variable

2-step cross-sectional – FF 96 portfolios (3 × 32)

Coefficient		M1	M2	M3	M4	M5	M6
Intercept	Estimate	0.0129	0.0147	0.0132	0.0148	0.0127	0.0143
	std. error	0.0017	0.0023	0.0017	0.0023	0.0017	0.0023
	t value	7.4520	6.3740	7.6410	6.3360	7.3890	6.2030
	p-value	0.0000‡	0.0000‡	0.0000‡	0.0000‡	0.0000‡	0.0000‡
Mkt	Estimate	−0.0012	−0.0028	−0.0016	−0.0031	−0.0008	−0.0023
	std. error	0.0016	0.0021	0.0016	0.0022	0.0016	0.0022
	t value	−0.7100	−1.3200	−0.9920	−1.4150	−0.4820	−1.0540
	p-value	0.4798	0.1903	0.3240	0.1606	0.6309	0.2946
SMB	Estimate	0.0041	0.0035	0.0040	0.0035	0.0044	0.0039
	std. error	0.0006	0.0007	0.0005	0.0008	0.0006	0.0008
	t value	7.4270	4.7820	7.2620	4.5910	7.6630	5.0910
	p-value	0.0000‡	0.0000‡	0.0000‡	0.0000‡	0.0000‡	0.0000‡
HLM	Estimate	−0.0018	−0.0016	−0.0024	−0.0022	−0.0025	−0.0023
	std. error	0.0008	0.0008	0.0009	0.0009	0.0009	0.0009
	t value	−2.3080	−2.0170	−2.7230	−2.4260	−2.8750	−2.5680
	p-value	0.0232†	0.0466†	0.0078‡	0.0173†	0.0050‡	0.0119†
QMJ	Estimate		−0.0020		−0.0024		−0.0018
	std. error		0.0007		0.0007		0.0007
	t value		−2.8160		−3.6130		−2.5860
	p-value		0.0060‡		0.0005‡		0.0113†
ESG	Estimate	0.0026	0.0026			0.0020	0.0020
	std. error	0.0018	0.0017			0.0018	0.0018
	t value	1.4820	1.4690			1.1490	1.1540
	p-value	0.1417	0.1452			0.2536	0.2516
ESGM	Estimate			0.0035	0.0031	0.0029	0.0026
	std. error			0.0036	0.0036	0.0036	0.0036
	t value			0.9520	0.8530	0.8270	0.7250
	p-value			0.3434	0.3958	0.4102	0.4703
Adjusted-R2		0.3750	0.3780	0.3650	0.3650	0.3880	0.3890

Note: ‡– p-value < 0.01; †– p-value < 0.05; * – p-value < 0.1.

Table 12
GMM cross-section regression using as dependent variable the excess return of the 451 stocks

GMM cross-sectional

Coefficient		M1	M2	M3	M4	M5	M6
Intercept	Estimate	0.0087	0.0069	0.0080	0.0068	0.0085	0.0071
	std. error	0.0045	0.0043	0.0043	0.0042	0.0043	0.0043
	t value	19.1640	1.6216	1.8604	1.5938	1.9763	1.6584
	p-value	0.0550*	0.1050	0.0630*	0.1110	0.0480†	0.0970*
Mkt	Estimate	0.0060	0.0078	0.0069	0.0081	0.0062	0.0075
	std. error	0.0060	0.0062	0.0061	0.0063	0.0062	0.0064
	t value	0.9945	1.2507	1.1338	1.2907	0.9911	1.1835
	p-value	0.3200	0.2110	0.2570	0.1970	0.3220	0.2370
SMB	Estimate	0.0040	0.0048	0.0042	0.0049	0.0040	0.0050
	std. error	0.0044	0.0044	0.0043	0.0044	0.0044	0.0043
	t value	0.9202	1.1100	0.9609	1.1143	0.9199	1.1479
	p-value	0.3570	0.2670	0.3370	0.2650	0.3580	0.2510
HLM	Estimate	−0.0117	−0.0115	−0.0115	−0.0113	−0.0117	−0.0116
	std. error	0.0048	0.0047	0.0048	0.0048	0.0048	0.0047
	t value	−2.4501	−2.4220	−2.3854	−2.3753	−2.4377	−2.4860
	p-value	0.0140†	0.0150†	0.0170†	0.0180†	0.0150†	0.0130†
QMJ	Estimate		−0.0023		−0.0026		−0.0022
	std. error		0.0033		0.0033		0.0033
	t value		−0.6979		−0.7750		−0.6546
	p-value		0.4850		0.4380		0.5130
ESG	Estimate	−0.0026	−0.0020			−0.0024	−0.0028
	std. error	0.0014	0.0014			0.0025	0.0024
	t value	−1.8974	−1.4194			−0.9531	−1.1803
	p-value	0.0580*	0.1560			0.3410	0.2380
ESGM	Estimate			0.0032	0.0031	0.0028	0.0023
	std. error			0.0029	0.0029	0.0030	0.0030
	t value			1.1052	1.0449	0.9542	0.7903
	p-value			0.2690	0.2960	0.3400	0.4290
Adjusted-R		0.9080	0.9140	0.9060	0.9090	0.9080	914

Note: ‡– p-value < 0.01; †– p-value < 0.05; * – p-value < 0.1.

The ESG factor lambda remained negative in all models of Tables 12 and 13, but significant at a 10% level only in M1 of Table 12.

The ESGM factor lambda was insignificant but positive in all regressions in Tables 12, 13 and 14.

5. Conclusion

In this article we investigate whether good ESG practices lead to a lower cost of capital and higher equity valuation. We built an ESG factor based

Table 13
GMM cross-section regression using as dependent variable the 150 Fama and French portfolios

GMM – FF 150 (6 × 25)

Coefficient		M1	M2	M3	M4	M5	M6
Intercept	Estimate	0.0169	0.0171	0.0160	0.0163	0.0163	0.0165
	std. error	0.0050	0.0052	0.0053	0.0054	0.0053	0.0054
	t value	3.3656	3.2890	3.0074	3.0148	3.0727	3.0307
	p-value	0.0010‡	0.0010‡	0.0030‡	0.0030‡	0.0020‡	0.0020‡
Mkt	Estimate	−0.0049	−0.0050	−0.0389	−0.0041	−0.0043	−0.0044
	std. error	0.0076	0.0077	0.0076	0.0077	0.0076	0.0077
	t value	−0.6485	−0.6512	−0.5093	−0.5362	−0.5605	−0.5681
	p-value	0.5170	0.5150	0.6110	0.5920	0.5750	0.5700
SMB	Estimate	0.0020	0.0022	0.0031	0.0027	0.0029	0.0027
	std. error	0.0040	0.0034	0.0040	0.0034	0.0040	0.0034
	t value	0.6116	0.6651	0.7555	0.7897	0.7294	0.7782
	p-value	0.5410	0.5060	0.4500	0.4300	0.4660	0.4360
HLM	Estimate	−0.0018	−0.0016	−0.0024	−0.0023	−0.0024	−0.0023
	std. error	0.0047	0.0047	0.0045	0.0045	0.0045	0.0045
	t value	−0.3783	−0.3541	−0.5372	−0.5062	−0.5376	−0.5105
	p-value	0.7050	0.7230	0.5910	0.6130	0.5910	0.6100
QMJ	Estimate		−0.0013		−0.0013		−0.0013
	std. error		0.0039		0.0039		0.0039
	t value		−0.3401		−0.3333		−0.3357
	p-value		0.7340		0.7390		0.7370
ESG	Estimate	−0.0026	−0.0025			−0.0029	−0.0028
	std. error	0.0044	0.0043			0.0037	0.0036
	t value	−0.6084	−0.5857			−0.7826	−0.7632
	p-value	0.5430	0.5580			0.4340	0.4450
ESGM	Estimate			0.0080	0.0078	0.0080	0.0078
	std. error			0.0069	0.0069	0.0069	0.0069
	t value			1.1596	1.1252	1.1637	1.1411
	p-value			0.2460	0.2600	0.2450	0.2540
Adjusted-R2		0.2260	0.2220	0.2480	0.2450	0.2450	0.2410

Note: ‡– p-value < 0.01; †– p-value < 0.05; * – p-value < 0.1.

Table 14
GMM cress-section regression using as dependent variable the 96 Fama and French portfolios

GMM – FF 96 (3 × 32)

Coefficient		M1	M2	M3	M4	M5	M6
Intercept	Estimate	0.0129	0.0147	0.0132	0.0148	0.0127	0.0143
	std. error	0.0100	0.0083	0.0096	0.0085	0.0099	0.0084
	t value	1.2874	1.7758	1.3767	1.7361	1.2736	1.6947
	p-value	0.1980	0.0760*	0.1690	0.0830*	0.2030	0.0900*
Mkt	Estimate	−0.0012	−0.0028	−0.0016	−0.0031	−0.0008	−0.0023
	std. error	0.0116	0.0102	0.0111	0.0103	0.0114	0.0102
	t value	−0.0996	−0.2770	−0.1438	−0.2956	−0.0686	−0.2233
	p-value	0.9210	0.7820	0.8860	0.7680	0.9450	0.8230
SMB	Estimate	0.0041	0.0035	0.0040	0.0035	0.0044	0.0039
	std. error	0.0040	0.0040	0.0041	0.0041	0.0040	0.0040
	t value	1.0270	0.8833	0.9661	0.8371	1.0993	0.9874
	p-value	0.3040	0.3770	0.3340	0.4030	0.2720	0.3230
HLM	Estimate	−0.0018	−0.0016	−0.0024	−0.0022	−0.0025	−0.0023
	std. error	0.0047	0.0049	0.0046	0.0047	0.0047	0.0048
	t value	−0.3802	−0.3309	−0.5315	−0.4746	−0.5384	−0.4835
	p-value	0.7040	0.7410	0.5950	0.6350	0.5900	0.6290
QMJ	Estimate		−0.0020		−0.0024		−0.0018
	std. error		0.0044		0.0047		0.0044
	t value		−0.4502		−0.5142		−0.4176
	p-value		0.6530		0.6070		0.6760
ESG	Estimate	0.0026	0.0026			0.0020	0.0020
	std. error	0.0046	0.0046			0.0041	0.0042
	t value	0.5590	0.5541			0.4989	0.4903
	p-value	0.5760	0.5800			0.6180	0.6240
ESGM	Estimate			0.0035	0.0031	0.0029	0.0026
	std. error			0.0057	0.0063	0.0060	0.0068
	t value			0.6018	0.4961	0.4936	0.3836
	p-value			0.5470	0.6200	0.6220	0.7010
Adjusted-R2		0.3750	0.3780	0.3650	0.3650	0.3880	0.3890

Note: ‡– p-value < 0.01; †– p-value < 0.05; * – p-value < 0.1.

on the static ESG score by Sustainalytics, and an ESGM factor, related to the variation of the ESG classifications—the ESG momentum. We raised a first hypothesis (H1), according to which there is a negative relation between ESG score and return. In other words, we propose that investors require a risk premium to invest in companies with poor ESG practices. We ran a two-stage cross-section regression, controlling by Fama and French factors and a quality factor. Our results indicate that the share of companies with the worst ESG scores had a return between 0.2% and 0.29% higher than companies with the highest ESG scores. However, with this test it is not possible to identify the direction of the causality.

We raised a second hypothesis, which proposes that changes in ESG score —or ESG momentum—impact the cost of capital and share price. The results of a two-stage cross-section regression indicates that there is a positive and significant relationship between the improvement of ESG practices and returns. A portfolio long in the stocks with the highest upgrades in ESG score and short in the stocks with the highest downgrades in ESG score had a return premium between 0.23% and 0.35%. The magnitude of the impact in the return is much more expressive for score upgrades than for score downgrades. This indicates that investors precify positively ESG practices, and that the improvement in the sustainable practices lead to an appreciation in the equity value. However, given the divergence of ESG ratings of different providers (Berg et al., 2022), it is not possible to generalize our results based on Sustainalityc ESG rank to other providers.

When we ran a GMM two-step regression, a more robust methodology, we found ESG and ESGM premiums of similar magnitudes, however all the results were statistically insignificant.

Some adversities may explain the lack of robustness of the proposed risk factors. (i) The divergence among ESG scores of different providers disperses the potential effect of investor preference for sustainable characteristics on asset prices. (ii) We built ESG and ESGM factors based on ESG rank, which is a relative score of a firm to its peers in the same industrial sector. Absolute scores probably would increase the magnitude of ESG momentum and the dispersion of ESG score. Unfortunately, we were not able to access time series of Sustainalytics absolute scores to test if the results would be more significant. (iii) The short history of ESG data represents a significant drawback to conducting robust research and testing. With an ESG Momentum database of only 6 years (June 2015 to June 2021), the lack of significance in some t-tests would not be entirely unexpected. Possibly, it will still take a few years of ESG quality data before it is possible to accurately test the claim that ESG momentum is a robust factor, as pointed out by Giese et al. (2019b). (iv)

Given the robustness of the GMM methodology, even risk premiums of factors widely consolidated in the literature lost significance, that is, the ESGM factor does not necessarily have less academic relevance than the other factors used in the study. Furthermore, we can argue that the maintenance of positive premiums for the ESGM factor throughout the different models, or even the failure to obtain significant negative premiums for this factor, is, in itself, a result that encourages the use of ESG momentum in the management of portfolios.

Issues related to sustainability and social responsibility should permeate the investment universe in the future. This work adds to the literature bringing favourable, yet weak, evidence that the improvement in the quality of sustainable practices lead to firm value appreciation.

Future research, with a larger and more standardized database have the potential to produce more robust results about the existence of ESG and ESGM risk factors, and this is a promising research topic in the portfolio management process for years to come.

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A questão da segurança jurídica em securitização da *tokenização* dos certificados das cédulas de produto rural verde e dos créditos do carbono

The legal issue in the securitization of tokenization of the green rural product certificates and carbon credits

Elizete Antunes Teixeira Nogueira[†]

Resumo O objetivo deste estudo consistiu em demonstrar a segurança jurídica no processo de financeirização por meio da securitização da *tokenização* dos certificados das cédulas de produto rural verde e dos títulos dos créditos do carbono. Realizou-se uma pesquisa exploratória, descritiva e documental com ênfase no marco regulatório das securitizadoras, Lei nº 14.430/22. Concluiu-se que a securitização por *tokenização* tem potencial para ampliar as alternativas para financiamentos e investimentos por meio de produtos inovadores, como: emissões dos certificados das cédulas de produto rural verde e dos títulos dos créditos do carbono, proporcionando liquidez dos mercados secundários e desenvolvimento sustentável de baixo carbono. Além da segurança jurídica interna, haja vista a alienação fiduciária em garantia por constituir o patrimônio de afetação, sendo necessárias definições legais interjurisdições.

Palavras-chave: Segurança jurídica; Securitização; *Tokenização*
Código JEL: G18, O16, Q01, Q56.

Abstract The objective of this study was to demonstrate the legal security in the process of financialization through the securitization of tokenization of the certificates of the green rural product and the titles of the carbon credits. An exploratory, descriptive, and documentary research was carried out with emphasis on the regulatory framework of securitizers, Law nº. 14.430/22. It was concluded that tokenization securitization has the potential to expand alternatives for financing and investments through innovative products such as the issuance of certificates of the green rural product and carbon credit titles, providing liquidity for secondary markets and sustainable development with low carbon. In addition to providing internal legal security, given the fiduciary alienation as a guarantee that constitutes the affected assets, legal definitions are necessary across jurisdictions.

Keywords: Legal security; Securitization; Tokenization.
JEL Code: G18, Q01, Q56.

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[†]Universidade Federal de São João del-Rei, Brasil: elizete@ufsj.edu.br

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1. Introdução

O processo de financeirização por securitização decorre de ruptura do paradigma da regulação pelos Estados às desregulamentações dos sistemas financeiros e à liberalização desses para maior participação das iniciativas privadas. Assim, as transformações Estado-mercado por institucionalização da securitização possibilita inovações em produtos financeiros e, implicitamente, proporciona liquidez e recursos no sistema financeiro.

No Brasil, a securitização foi institucionalizada com a Lei da Alienação Fiduciária em Garantia, Lei nº 9.514/97 (Brasil, 1997), do Sistema Financeiro Imobiliário, e a regulamentação das emissões dos créditos lastreados em um direito real, que consiste na alienação fiduciária em garantia prevista no art. 167, I, 35, da Lei de Registro Públicos, Lei nº 6.015/73 (Brasil, 1973).

Nesse sentido, tem-se o patrimônio de afetação assim constituído: de um lado, pelos direitos creditórios que lastreiam os títulos emitidos e, de outro lado, pelas obrigações a ele relacionados (Chalhub, 2002, p. 338). Esse vínculo jurídico proporciona segurança jurídica aos certificados de recebíveis pelas companhias securitizadoras. A securitização é um processo que permite a transformação de dívidas em títulos de crédito.

Assim a criação de ativos securitizados (Gotham, 2006; Sassen, 2016) tornou-se uma inovação capaz de promover a integração de mercados financeiros e capturar importantes cadeias de crédito e dívidas por meio da transformação de mercadorias de baixa liquidez em títulos líquidos.

Estudos já realizados apresentaram que as securitizadoras exercem uma importância no processo de financeirização da economia, proporcionado desenvolvimento econômico e conexões entre mercado financeiro, imobiliário e de capitais. O desenvolvimento de ativos financeiros derivativos, inovadores e conversíveis entre as contas do Ativo/Passivo e Débito/Crédito com possibilidade de liquidez, aliados às questões temporais, ou seja, o longo prazo com possibilidades de rentabilidades e a obrigatoriedade de alienações fiduciárias, ou seja, lastros, possibilita a segurança jurídica.

Com o "novo" marco regulatório definido pela Lei nº 14.430, de 03 de agosto de 2022 (Brasil, 2022d), a securitização obtém uma legislação específica, a qual dispõe sobre a emissão de Letra de Risco de Seguro (LRS) por Sociedade Seguradora de Propósito Específico (SSPE), sobre as regras gerais aplicáveis à securitização de direitos creditórios e à emissão de Certificados de Recebíveis e sobre a flexibilização do requisito de instituição financeira para a prestação do serviço de escrituração e de custódia de valores mobiliários.

No que concerne à segurança jurídica, a Lei nº 14.430/22 (Brasil, 2022d),

na seção III, traz dispositivos sobre a independência, ou seja, a separação patrimonial das operações. Em seu art. 16, § 1º, a independência patrimonial de que trata o *caput* deste artigo abrange a identidade própria e individualizada nos aspectos regulamentares, cadastrais, atuariais, contábeis, de investimentos e obrigações e será operacionalizada por meio da inscrição de cada operação no CNPJ.

O problema de pesquisa consistiu em como desenvolver alternativas de financiamentos e investimentos que visem um desenvolvimento econômico sustentável em uma política de baixo carbono com segurança jurídica para os investidores?

Assim, o objetivo deste estudo consistiu em demonstrar a segurança jurídica no processo de financeirização por meio da securitização por *tokenização* de certificados das cédulas de produto rural verde e dos certificados dos títulos de créditos do carbono como alternativas de financiamentos e de investimentos de recursos para um desenvolvimento econômico sustentável em um contexto de políticas de baixo carbono.

Especificamente, o estudo propõe abordar:

(i) a importância do processo de financeirização da economia por securitização;
(ii) a segurança jurídica no processo de financeirização imobiliária por securitização nas emissões de certificados de recebíveis imobiliários;
(iii) a segurança jurídica no processo de financeirização no agronegócio por securitização nas emissões de certificados de recebíveis do agronegócio; e
(iv) a segurança jurídica no processo de financeirização por meio da securitização dos certificados de cédulas de produto rural verde e dos títulos de crédito do carbono.

2. O processo de financeirização por meio da securitização

O processo de financeirização consiste em uma construção histórica em que há um deslocamento do monopólio do crédito e do sistema de pagamento bancário por parte dos Estados para as iniciativas privadas. Nesse sentido, a oferta de crédito e o sistema de pagamento não estão totalmente controlados pelos bancos centrais e comerciais nacionais, há uma forte tendência à financeirização com moedas privadas.

As contribuições pioneiras, no Brasil, para a compreensão do capitalismo moderno a partir do conceito de financeirização são do pesquisador Braga (1997) como sendo um padrão sistêmico de riqueza, que se originou nos anos 60, a partir de modelos de securitização pelos Estados Unidos. Para Braga

(2016), a financeirização da riqueza constitui uma forma de definir, gerir e realizar a riqueza, nesses termos:

> (...) trata-se de um padrão sistêmico porque a financeirização está constituída por componentes fundamentais da organização capitalista, entrelaçados de maneira a estabelecer uma dinâmica estrutural segundo princípios de uma lógica financeira geral. Neste sentido, ela não decorre apenas da práxis de segmentos ou setores – o capital bancário, os rentistas tradicionais – mas, ao contrário, tem marcado as estratégias de todos os agentes privados relevantes, condicionado a operação das finanças e dispêndios públicos, modificado a dinâmica macroeconômica. Enfim, tem sido intrínseca ao sistema tal como ele está atualmente configurado (Braga, 1997, p. 196).

Esse processo de "financeirização da riqueza", de acordo com Braga (2016, p. 48), é, em suma, um verdadeiro paroxismo nos capitalismos centrais, nos quais a gestão especulativa da riqueza é levada a extremos e, ainda assim, paradoxalmente articulada com a reprodução ampliada, redefinindo a dinâmica das crises e das reestruturações, como demonstrado. E, enquanto paradoxo, põe em xeque sistemas e pressupostos, de diferentes escolas, na interpretação do capitalismo, que até hoje são apresentados como atuais, consistentes e incontestáveis.

As securitizadoras exercem uma importância no processo de financeirização da economia tanto no setor privado, como no setor público. Esse processo tem diversas denominações como "financialização" (Harvey, 2005, citado por Royer (2009, p. 24)), "financeirização do crédito imobiliário" (Royer, 2009, p. 20), "expansão do complexo imobiliário-financeiro" (Rolnik, 2015, p. 255), "mercado imobiliário financeirizado" (Hoyler, 2015) e "financeirização do mercado imobiliário", que, segundo Ferreira Neto (2019), abarca as relações entre os mercados imobiliário, financeiro e de capitais.

A tendência à financeirização da riqueza com moedas privadas a partir da capacidade da macroestrutura financeira de criar crédito em geral (via dívida direta ou indireta) e operar mecanismos de pagamento, ainda que parcialmente, à margem do controle das autoridades monetárias (Braga, 1997), faz-se nas operações da macroestrutura financeira, o que impulsiona a alteração das formas de crédito pela ampliação da securitização via inovações em ativos financeiros e da temporalidade.

> A temporalidade das finanças proporciona movimentos na macroestrutura financeira, implica a flexibilização temporal das relações débito/crédito, das posições ativas/passivas, do tempo de valorização dos capitais. A grande mobilidade entre as diversas formas de cristalização da riqueza, na busca de maior e mais rápida rentabilidade, dada pela conversão das diversas temporalidades dos ativos em uma 'outra' estrutura temporal de valorização, sempre atualizada, com os sucessivos impulsos de revisões das decisões passadas. Esse processo torna o tempo e as decisões capitalistas reversíveis (Braga, 1997, p. 229).

A temporalidade das finanças decorre das possibilidades operacionais, das inovações em produtos financeiros, das interconexões entre mercados financeiros e de capitais, e da conversibilidade entre moedas, créditos e patrimônio; todo esse processo procede das operações de securitização. Mas, afinal, o que são e o que fazem as companhias securitizadoras?

As companhias securitizadoras, de acordo com o art. 18 da Lei nº 14.430/22,

> (...) são instituições não financeiras constituídas sob a forma de sociedade por ações, que têm por finalidade realizar operações de securitização. Em seu parágrafo único, é considerada operação de securitização a aquisição de direitos creditórios para lastrear a emissão de Certificados de Recebíveis ou outros títulos e valores mobiliários perante investidores, cujo pagamento é primariamente condicionado ao recebimento de recursos dos direitos creditórios e dos demais bens, direitos que o lastreiam (Brasil, 2022d).

Nas hipóteses em que os certificados de recebíveis imobiliários tiverem sido emitidos com lastro em créditos representados por cédula de crédito imobiliário, o regime fiduciário será registrado na instituição financeira à qual tiver sido atribuído o encargo de custodiante das cédulas. A securitização incumbirá a uma companhia securitizadora.

3. A segurança jurídica no processo de financeirização imobiliária por securitização de certificados de recebíveis

No Brasil, o processo de financeirização imobiliária intensificou a partir da criação do Sistema Financeiro Imobiliário (SFI), instituído pela Lei nº

9.514/97, em seu artigo 1º, diz que tem por finalidade a promoção do financiamento imobiliário em geral (Brasil, 1997).

Esse modelo possibilitou a segurança jurídica por meio de emissões dos certificados de recebíveis lastreados em garantias reais, como a alienação fiduciária, o regime fiduciário e o patrimônio de afetação pelas companhias securitizadoras. Estas promovem o processo de financeirização imobiliária por meio das conexões entre mercados financeiro, imobiliário e de capitais.

No art. 3º da Lei nº 9.514/97, as companhias securitizadoras de créditos imobiliários, instituições não financeiras constituídas sob a forma de sociedade por ações, terão por finalidade a aquisição e securitização desses créditos e a emissão e colocação, no mercado financeiro, de certificados de recebíveis imobiliários, podendo emitir outros títulos de crédito, realizar negócios e prestar serviços compatíveis com as suas atividades (Brasil, 1997).

Esses títulos financeiros de base imobiliária são os Certificados de Recebíveis Imobiliários (CRI), as Letras de Crédito Imobiliário (LCI), as Cédulas de Crédito Imobiliário (CCI) e, mais recentemente, as Letras Imobiliárias Garantidas (LIG). dos Santos Pereira (2015) conclui que as LCI foram os instrumentos mais relevantes na mudança do quadro geral do circuito financeiro imobiliário entre os anos de 1990 e 2015.

Em conformidade com a definição do SFI, os CRI são classificados como, segundo Royer (2009, p. 100), "um título de crédito nominativo de livre negociação lastreado em créditos imobiliários e que constitui promessa de pagamento em dinheiro". Para esse autor, os recebíveis imobiliários se convertem nas CCI, que, na definição do SFI, é um "título executivo extrajudicial que representa direitos de créditos imobiliários com fluxos de pagamento parcelados".

Os certificados de recebíveis são de emissão exclusiva das companhias securitizadoras. De acordo com o art. 20, da Lei nº 14.430/22, têm-se o conceito e o lastro:

> **Art. 20.** Os certificados de recebíveis são títulos de crédito nominativos, emitidos de forma escritural, de emissão exclusiva de companhia securitizadora, de livre negociação, constituem promessa de pagamento em dinheiro, preservada a possibilidade de dação em pagamento, e são títulos executivos extrajudiciais.
> **§ 1º** Quando ofertados publicamente ou admitidos à negociação em mercado regulamentado de valores mobiliários, os certificados de recebíveis são considerados valores mobiliários.

> **§ 2º** Os direitos creditórios que lastrearão os certificados de recebíveis serão previamente identificados, atenderão aos critérios de elegibilidade previstos no termo de securitização e deverão ser adquiridos até a data de integralização dos certificados de recebíveis (Brasil, 2022d).

Pesquisas já realizadas demonstraram correlações positivas entre o crescimento do mercado imobiliário e a financeirização por securitização de certificados de recebíveis em que por meio desses processos ocorrem transformações, principalmente, nos espaços urbanos (Kalinoski e Procopiuck, 2022; Melazzo e de Abreu, 2019; Abreu, 2019; Ferreira Neto, 2019; de Oliveira Royer, 2016).

Para de Oliveira Royer (2016), "não há como ignorar a importância do crédito e do fomento de mercados privados para o financiamento e a promoção de políticas de infraestrutura, em especial da política habitacional". Ainda, afirma que "um dos instrumentos financeiros centrais na lei do Sistema Financeiro Imobiliário é o Certificado de Recebível Imobiliário – CRI".

Os CRI são de emissão exclusiva das companhias securitizadoras. Para de de Oliveira Royer (2016), estes podem ser lastreados em fluxos de recebíveis (pagamentos) de empreendimentos imobiliários específicos ou de um conjunto pulverizado de operações de crédito imobiliário. Os CRI também compõem os ativos de fundos de investimentos, como os dos Fundos de Investimentos em Direitos Creditórios (FDIC) e os dos Fundos de Investimentos Imobiliários (FII).

Interessante ressaltar, segundo de de Oliveira Royer (2016), que, no caso dos FII e FIDC, seus ativos compreendem uma gama relativamente diversificada de instrumentos não necessariamente vinculados a operações de financiamento habitacional. Os resultados da pesquisa realizada por de de Oliveira Royer (2016) demonstraram a importância da participação do FGTS para alavancar os CRI, como um importante investidor institucional, além da valorização dos CRI e do redirecionamento destes para investimentos imobiliários; assim, impacta a produção do espaço por meio de frentes de expansão imobiliária nas cidades.

Ademais, a securitização de recebíveis consiste em alternativas de financiamentos de operações mercantis com fins de captação de recursos para o capital de giro, que foram demonstradas nos resultados das pesquisas de Schreiber e Martins (2022). São Fundos de Investimentos em Direitos Creditórios (FIDC), e esses são fundamentados no papel de Sociedades de Propósitos Específicos (SPE). Os resultados das suas pesquisas evidenciaram que a se-

curitização pode contribuir de forma positiva para diluir riscos e aumentar a capacidade de financiamento.

4. A segurança jurídica em securitização de certificados de recebíveis do agronegócio

As securitizações de dívidas rurais são resultados de pesquisas em que o Banco do Brasil apresentava impactos negativos no Balanço Patrimonial ocasionados pela inadimplência dos produtores, e por meio da aprovação da Lei nº 9.138, de 1995, a securitização das dívidas foi essencial, de acordo Silvestrini e Lima (2011), para reverter os prejuízos em lucros.

Em 1994, por meio da Lei nº 8.929 (Brasil, 1994), criou-se o primeiro título privado, a cédula de produto rural (CPR), que tem por objetivo realizar o financiamento da produção através de uma venda antecipada. E a cédula de produto rural financeira (CPR-FINANCEIRA), Lei 10.200/01, que prevê o pagamento em dinheiro pelo produtor na data de seu vencimento (Oliveira, 2007 *apud* Fernandes et al. (2017)).

Por meio da Lei nº 11.076/04 (Brasil, 2004), novos títulos foram criados com o objetivo de maximizar a captação de recursos para o financiamento do agronegócio, como: o Certificado de Depósito Agropecuário (CDA), que é um título de crédito emitido por armazenadores, que representam promessa de entrega de produtos do agronegócio depositados no armazém; e o Warrant Agropecuário (WA), como título de crédito, que dá direito ao penhor agrícola descritos no CDA.

A Instrução CVM nº 60 (Brasil, 2021a) dispõe sobre o regime dos certificados de recebíveis do agronegócio (CRA), objeto de oferta pública de distribuição, em seu art. 2º define que o CRA é título de crédito nominativo, escritural, de livre negociação e representativo de promessa de pagamento em dinheiro, sendo a sua emissão exclusiva das companhias securitizadoras de direitos creditórios do agronegócio ("securitizadora" ou "emissora").

No que concerne à segurança jurídica do CRA, o art. 3º da Instrução CVM nº 60 (Brasil, 2021a) diz que este deve ser vinculado a direitos creditórios originários de negócios realizados entre produtores rurais, ou suas cooperativas, e terceiros, inclusive financiamentos ou empréstimos, relacionados com a produção, a comercialização, o beneficiamento ou a industrialização de: i) produtos agropecuários, ii) insumos agropecuários ou iii) máquinas e implementos utilizados na atividade agropecuária.

Na sequência, a Instrução CVM nº 60, no § 4º, art. 3º, trata dos direitos creditórios do agronegócio referidos no *caput* são:

I direitos creditórios que tenham como devedores

> ou credores originais pessoas físicas ou jurídicas caracterizadas como produtores rurais ou suas cooperativas, independente da destinação dos recursos a ser dada pelo devedor ou pelo cedente;
> **II** títulos de dívida emitidos pelos terceiros referidos no caput, vinculados a uma relação comercial existente entre o terceiro e produtores rurais ou suas cooperativas; ou
> **III** títulos de dívida emitidos por produtores rurais, ou suas cooperativas.
> **§ 5º** Também são aceitos como lastro de CRA os direitos creditórios de negócios realizados entre distribuidores e terceiros, desde que estejam explicitamente vinculados, por meio de instrumentos contratuais ou de títulos de crédito, a vendas do distribuidor aos produtores rurais, cabendo à companhia securitizadora comprová-los anteriormente à emissão do CRA (Brasil, 2021a).

A Lei nº 14.430/22 (Brasil, 2022d), além de criar o marco legal da securitização e instituir os Certificados de Recebíveis, também alterou diversas disposições como as Leis nº 9.514 (Brasil, 1997) e nº 11.076 (Brasil, 2004). Com isso, consolidaram as regras gerais aplicáveis às companhias securitizadoras e suas emissões, incluindo os Certificados de Recebíveis Imobiliários (CRI) e os Certificados de Recebíveis do Agronegócio (CRA).

Gomes (2022), superintendente de Supervisão de Securitização da CVM, destaca o impacto positivo dessa norma para o mercado: "A CVM atuou com foco em promover celeridade ao mercado, especialmente considerando que a Lei 14.430 foi publicada em agosto de 2022. Então, para Gomes, observa-se o potencial benefício para diferentes setores da atividade econômica, para além dos imobiliários e do agronegócio, ao tornar imediata a possível realização de ofertas públicas com esforços restritos de certificados recebíveis"

Por meio da Resolução CVM nº 165 (Brasil, 2022b), equiparam-se os Certificados de Recebíveis (CR) aos Certificados de Recebíveis imobiliários e do agronegócio, sendo que a oferta pública, regulada pela Resolução CVM nº 160 (Brasil, 2022a), de 13 de julho de 2022, com previsão na Lei nº 14.430/22 (Brasil, 2022d), entra em vigor em janeiro de 2023.

5. A segurança jurídica em securitização por *tokenização* de certificados das cédulas de produto rural verde e dos créditos do carbono

A alternativa da securitização por processo de *tokenização* de certificados das cédulas de produto rural verde e dos créditos do carbono possibilita a ampliação dos volumes de negócios no mercado secundário; e, consequentemente, recursos para um desenvolvimento econômico sustentável em uma política de baixo carbono.

Os requisitos para o lançamento das Cédulas de Produto Rural Verde (CPR Verde) encontram-se no dispositivo 3º, da Lei nº 8.929/94 (Brasil, 1994), equivalentes aos das Cédulas do Produto Rural (CPR). No art. 3º do Decreto nº 10.828/21 (Brasil, 2021b) prevê que esse certificado será acompanhado de certificação por terceira parte para indicação e especificação dos produtos rurais que o lastreiam.

O art. 1º do Decreto nº 10.828/21 (Brasil, 2021b) tem a regulamentação da emissão das Cédulas de Produto Rural Verde (CPR Verde) relacionada às atividades de conservação e recuperação de florestas nativas e de seus biomas. A autorização para as emissões destas deve resultar em:

> **I** redução de emissões de gases de efeito estufa;
> **II** manutenção ou aumento do estoque de carbono florestal;
> **III** redução do desmatamento e da degradação de vegetação nativa;
> **IV** conservação da biodiversidade;
> **V** conservação dos recursos hídricos;
> **VI** conservação do solo; ou
> **VII** outros benefícios ecossistêmicos (Brasil, 2021b).

Nesse sentido, a proposta para a securitização por processo de *tokenização* de certificados das cédulas de produto rural verde e dos certificados dos créditos de carbono consistirão em alternativas viáveis, se lastreados em Cédulas de Produto Rural Verde (CPR Verde), em Mecanismos de Produção Limpa (MDL) e em Projetos de Energias Renováveis.

O processo de *tokenização* meio dos *Security Token Offerings* (STO) é uma forma de arrecadação de fundos, que envolve a oferta ou a emissão de criptoativos para investidores, nacionais e/ou internacionais, ou representa um ativo ou valor mobiliário de acordo com as leis das jurisdições do país onde são emitidos (Porto e Goulart, 2022).

Os *tokens* lastreados por valores mobiliários, pode se fazer necessária a figura de um custodiante especializado. Os criptoativos podem ser também

direitos sobre ativos subjacentes, que já são objeto de regulação existente, portanto, ocorre, em diferentes jurisdições, um aproveitamento do marco regulatório já existente para a emissão, oferta e custódia desse tipo de ativo (Porto e Goulart, 2022).

O Decreto-lei nº 11.075/22 (Brasil, 2022c) estabelece os procedimentos para a elaboração dos planos setoriais de mitigação das mudanças climáticas e institui o sistema nacional de emissões de gases de efeito estufa. Assim, com fins da efetivação dessas políticas, o art. 2º preconiza:

> **I** crédito de carbono - ativo financeiro, ambiental, transferível e representativo de redução ou remoção de uma tonelada de dióxido de carbono equivalente, que tenha sido reconhecido e emitido como crédito no mercado voluntário ou regulado (...)
> **III** crédito certificado de redução de emissões - crédito de carbono que tenha sido registrado no Sinare;
> **IV** compensação de emissões de gases de efeito estufa - mecanismo pelo qual a pessoa natural ou jurídica, de direito público ou privado, compensa emissões de gases de efeito estufa geradas em decorrência de suas atividades, por meio de suas próprias remoções contabilizadas em seu inventário de gases de efeito estufa ou mediante aquisição e efetiva aposentadoria de crédito certificado de redução de emissões (...) (Brasil, 2022c).

O dispositivo 7º desse Decreto, o Mercado Brasileiro de Redução de Emissões constitui mecanismo de gestão ambiental e será instrumento de operacionalização dos Planos Setoriais de Mitigação das Mudanças Climáticas, com vistas a atuar como ferramenta à implementação dos compromissos de redução de emissões, mediante a utilização e transação dos créditos certificados de redução de emissões (Brasil, 2022c).

Para fins operacionais, o art. 8º institui o Sistema Nacional de Redução de Emissões de Gases de Efeito Estufa (Sinare), cuja finalidade é servir de central única de registro de emissões, remoções, reduções e compensações de gases de efeito estufa e de atos de comércio, de transferências, de transações e de aposentadoria de créditos certificados de redução de emissões:

> **§ 1º** Ato conjunto dos Ministros de Estado do Meio Ambiente e da Economia estabelecerá as regras sobre:

> **I** o registro;
> **II** o padrão de certificação do Sinare;
> **III** o credenciamento de certificadoras e centrais de custódia;
> **IV** a implementação, a operacionalização e a gestão do Sinare;
> **V** o registro público e acessível, em ambiente digital, dos projetos, iniciativas e programas de geração de crédito certificado de redução de emissões e compensação de emissões de gases de efeito estufa; e
> **VI** os critérios para compatibilização, quando viável técnica e economicamente, de outros ativos representativos de redução ou remoção de gases de efeito estufa com os créditos de carbono reconhecidos pelo Sinare, por proposição do órgão ou da entidade competente pelos referidos ativos (Brasil, 2022c).

Por meio do art. 19, da Lei nº 14.430/22 (Brasil, 2022d), compete à Comissão de Valores Mobiliários (CVM) editar as normas sobre a emissão pública de Certificados de Recebíveis e outros valores mobiliários representativos de operações de securitização de tais direitos.

Tendo em vista a previsão legal do parágrafo único, do art. 19, da Lei nº 14.430/22 (Brasil, 2022d), em que a CVM poderá dispensar as companhias securitizadoras registradas de aplicar disposições da Lei nº 6.404, de 15 de dezembro de 1976 (Brasil, 1976), desde que a dispensa não represente prejuízo ao interesse público, à proteção do público investidor e à informação adequada ao mercado de valores mobiliários (Brasil, 2022d).

Outro mecanismo para apurar a contabilização dos créditos do carbono é o Cadastro Ambiental Rural (CAR). De acordo com Prolo (2022), tem um cadastro de 4,2 milhões de imóveis rurais no território brasileiro. O CAR permite avaliar os imóveis individuais sob tutela do Código Florestal e, a partir disso, estabelecer a necessidade de restauração florestal ou uma possibilidade de negociação de excedentes florestais.

O Código Florestal, Lei nº 12.651/12 (Brasil, 2012), no art. 1º, estabelece normas gerais sobre a proteção da vegetação, áreas de Preservação Permanente e áreas de Reserva Legal; a exploração florestal, o suprimento de matéria-prima florestal, o controle da origem dos produtos florestais e o controle e prevenção dos incêndios florestais; e prevê instrumentos econômicos e financeiros para o alcance de seus objetivos. Especificamente sobre as áreas de reserva legal, o art. 12 diz que:

> (. . .) todo imóvel rural deve manter área com cobertura de vegetação nativa, a título de Reserva Legal, sem prejuízo da aplicação das normas sobre as áreas de Preservação Permanente, observados os seguintes percentuais mínimos em relação à área do imóvel, excetuados os casos previstos no art. 68 desta Lei:
>
> **I** localizado na Amazônia Legal:
>
> (i) 80% (oitenta por cento), no imóvel situado em área de florestas;
>
> (ii) 35% (trinta e cinco por cento), no imóvel situado em área de cerrado;
>
> (iii) 20% (vinte por cento), no imóvel situado em área de campos gerais;
>
> **II** localizado nas demais regiões do País: 20% (vinte por cento) (Brasil, 2012).

Essas áreas reguladas pelo Decreto nº 10.828/21 (Brasil, 2021b) poderão compor as cédulas de produto rural verde e gerar os créditos do carbono. Com referência aos estudos coordenados por Porto e Goulart (2022), essas cédulas poderão ser caracterizadas como *asset backed tokens* são lastreados ou, de algum modo, atreladas a um produto ou bem material, seriam os criptoativos que podem ser emitidos no âmbito de um Índice Carbono Eficiente (ICO20), contabilizados em uma plataforma *blockchain*.

O uso desse tipo de tecnologia para encadeamento de blocos é o que se conhece por *blockchain*, onde cada bloco contém uma série de registros de transações, sendo cada bloco encadeado ao imediatamente anterior, contendo apenas transações validadas pela rede. Nesse aspecto, há um papel importante da regulação em definir parâmetros mínimos de governança, de controle ou instituir eventuais intermediários regulados para essas transações, garantindo segurança aos investidores e emissores de valores mobiliários digitais (Porto e Goulart, 2022).

Diante do exposto, a proposta de inovações em produtos financeiros por securitização de certificados de "descarbonização" por processos de *tokenização* de certificados das cédulas de produto rural verde, dos certificados dos créditos do carbono como valores mobiliários, uma vez lastreados às atividades de conservação e recuperação de florestas nativas e de seus biomas, aos mecanismos de desenvolvimento limpo e aos projetos de energias renováveis; consistirão em alternativas para o processo de financeirização para um desenvolvimento sustentável e uma política de baixo carbono.

6. Metodologia

Trata-se de estudos exploratórios acerca da financeirização por securitização em processos de *tokenização* de recebíveis por cédulas de produto rural verde e dos certificados dos créditos de carbono. Para Sampieri et al. (1991, p. 59), *apud* Révillion (2003) os estudos exploratórios são feitos, normalmente, quando o objetivo da pesquisa é examinar um tema ou problema de investigação pouco estudado ou que não tenha sido abordado antes. O objetivo dos estudos exploratórios consiste em familiarizar e elevar a compreensão de um problema de pesquisa em perspectiva.

A pesquisa se caracteriza como descritiva, segundo Gil (2008), tendo como objetivo primordial a descrição das características de determinada população, ou o fenômeno, ou o estabelecimento de relações entre variáveis. Aplicaram-se essas análises descritivas para os certificados de recebíveis imobiliários, os certificados do agronegócio e outros equivalentes, para identificar as contribuições destes nos processos de financeirização.

É bibliográfica e documental, conforme Gil (2008), por ter sido desenvolvida a partir de material já elaborado e constituído, principalmente, por artigos científicos e legislações. Com base nos artigos científicos, analisou-se o processo de financeirização por meio da securitização como alternativa para financiamentos e investimentos. Já, por meio das legislações, analisaram-se questões da segurança jurídica.

Dentre os documentos, foram analisadas as legislações referentes à temática da securitização, especificamente o novo marco regulatório, a Lei nº 14.430/22 (Brasil, 2022d), e as instruções normativas da Comissão de Valores Mobiliários. Foram analisadas, ainda, as legislações sobre os certificados de cédulas de produto rural verde e de créditos do carbono.

7. Considerações finais

Os resultados demonstraram que o processo de financeirização por meio da securitização de certificados de recebíveis imobiliários e agrícolas constituem alternativas de financiamentos e de investimentos; uma vez que as correlações foram positivas entre o crescimento desses mercados por securitização de certificados de recebíveis. Esses produtos financeiros são inovadores e têm a segurança jurídica para os investidores, haja vista o lastro em garantia real, que é a alienação fiduciária em garantia e o patrimônio de afetação.

As cédulas de produto rural verde relacionam-se às atividades de conservação e recuperação de florestas nativas e de seus biomas, uma vez constituídas; serão acompanhadas de certificações por terceira parte para indicação e especificação dos produtos que os lastreiam, tais como: as áreas equivalentes

com as respectivas obrigações constituídas nas emissões, como: a) redução de emissões de gases de efeito estufa; b) manutenção ou aumento do estoque de carbono florestal; c) redução do desmatamento e da degradação de vegetação nativa; d) conservação da biodiversidade; e) conservação dos recursos hídricos; f) conservação do solo; e g) outros benefícios ecossistêmicos. Assim, esses certificados lastreados, uma vez registrados no Registro de Imóveis proporcionarão segurança jurídica a essas cédulas.

A inovação proposta consiste na securitização por processos de *tokenização* de certificados de cédulas de produto rural verde e dos certificados dos créditos de carbono lastreados em atividades de conservação e recuperação de florestas nativas e de seus biomas, em Mecanismos de Produção Limpa e em Projetos de Energias Renováveis.

Conclui-se que a securitização por processos de *tokenização* dos certificados das cédulas de produto rural verde e dos créditos do carbono constituem alternativas para alavancar o mercado secundário, ampliando os volumes de negociações em âmbitos nacional e internacional no mercado de valores mobiliários, possibilitando-se, assim, o processo de financeirização e o desenvolvimento econômico sustentável em uma política de baixo carbono. Enfim, a segurança jurídica para os investidores em processos de *tokenização* demanda definições legais interjurisdições.

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O papel do BNDES na ampliação do financiamento aos ODS: Lições do edital de *Blended Finance*

The role of the BNDES in expanding funding for the SDGs: Lessons from the Blended Finance initiative

Leonardo de Moura Perdigão Pamplona[†]
Marcelo Marcolino[‡]
Julio Salarini[*]
Marcos Aurélio do Nascimento de Lima[**]

Resumo O Banco Nacional de Desenvolvimento Econômico e Social – BNDES tem um longo histórico de atuação na promoção do desenvolvimento econômico e social de forma sustentável. Além do crédito tradicional (direto ou por intermédio de agentes financeiros) e da participação acionária, oferece serviços de estruturação de projetos, gestão de fundos garantidores e aplica recursos não reembolsáveis para estimular projetos de alto impacto social e ambiental positivo. Em linha com a atuação mais recente de instituições de desenvolvimento e utilizando as melhores práticas mundiais, vem buscando utilizar mecanismos de finanças híbridas (*Blended Finance*) com o objetivo de alavancar recursos, sobretudo privados, para atingimento dos Objetivos de Desenvolvimento Sustentável (ODS). O objetivo do presente artigo é demonstrar as lições aprendidas com sua iniciativa e apontar caminhos e desafios no fomento à agenda no país.

Palavras-chave: Instrumentos financeiros inovadores; *Blended Finance*; Bancos de desenvolvimento; Capital catalítico; Objetivos de Desenvolvimento Sustentável.
Código JEL: G12, G32, M14.

Abstract The Brazilian Development Bank – BNDES has a long history promoting sustainable economic and social development. In addition to traditional credit (directly or through financial agents) and equity participation, it offers project structuring services, guarantee fund management and applies non-reimbursable resources to encourage projects with positive social and environmental impact. In line with most recent trends of development institutions and best global practices, it is starting to use Blended Finance structures to leverage private resources and achieve the Sustainable Development Goals (SDGs). The objective of this article is to demonstrate lessons learned from its initiative and point out paths and challenges in promoting the agenda in the country.

Keywords: Innovative financial instruments; Blended Finance; Development banks; Catalytic capital; Sustainable Development Goals.
JEL Code: G12, G32, M14.

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[†]Banco Nacional de Desenvolvimento Econômico e Social, Brasil: pamplona@bndes.gov.br
[‡]Banco Nacional de Desenvolvimento Econômico e Social, Brasil: marcolino@bndes.gov.br
[*]Banco Nacional de Desenvolvimento Econômico e Social, Brasil: julio.guiomar@bndes.gov.br
[**]Banco Nacional de Desenvolvimento Econômico e Social, Brasil: mnlima@bndes.gov.br

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1. Introdução

Em junho de 2022, o Banco Nacional de Desenvolvimento Econômico e Social (BNDES) alcançou 70 anos de história como instrumento do Estado Brasileiro para promoção do desenvolvimento, com a perene missão de formular e implementar soluções financeiras (e mesmo não financeiras) que atendam às mais diversas necessidades relacionadas ao seu propósito de promover o desenvolvimento econômico e social de forma sustentável.

O BNDES, desde sua fundação, vem atuando em diferentes segmentos e temas, como a viabilização de grandes investimentos em infraestrutura, a exemplo de energia e transportes, passando pela indústria de base e de bens de consumo, o desenvolvimento tecnológico e inovação, as micro e pequenas empresas, a agricultura, a exportação e o setor público, até chegar na atuação social, cultural e ambiental de forma mais direta.

Atualmente o Banco, além do crédito tradicional (direto ou por intermédio de agentes financeiros) e da participação acionária, oferece serviços de estruturação de projetos, gestão de fundos garantidores e aplica recursos não reembolsáveis para estimular projetos de alto impacto social e ambiental.

O presente artigo dá foco em uma experiência recente e inovadora para o BNDES, que constitui um degrau a mais na evolução de sua atuação socioambiental, que é a promoção de mecanismos de finanças híbridas (*Blended Finance*) com o objetivo de alavancar recursos, sobretudo privados, para investimentos em projetos com impacto social e ambiental positivos.

O texto está estruturado da seguinte maneira: a seção 2 apresenta um breve panorama do campo de *Blended Finance* em âmbito mundial e nacional, abordando o conceito e seu desenvolvimento nos anos recentes. A seção 3 aborda o histórico da atuação socioambiental do BNDES, a fim de contextualizar sua trajetória até o lançamento do edital e a seleção das primeiras estruturas de *Blended Finance* apoiadas pelo Banco. Em seguida, a seção 4 aborda a jornada específica do edital de seleção de estruturas de *Blended Finance* lançado pelo BNDES em maio de 2022, desde sua concepção e viabilização interna até o processo seletivo, com o objetivo de sistematizar algumas lições relacionadas tanto ao processo quanto aos instrumentos financeiros apresentados. Por fim, nas considerações finais tecemos algumas reflexões no intuito de contribuir para a continuidade da agenda de apoio ao *Blended Finance* no Brasil.

2. Panorama do campo de *Blended Finance* em âmbito mundial e nacional

Em estudo elaborado pela *Convergence*, rede internacional responsável por originar dados, inteligência e fomentar operações que utilizam o mecanismo de *Blended Finance*[1], estima-se que, para alcançarmos os Objetivos de Desenvolvimento Sustentável (ODS)[2] serão necessários investimentos anuais de 2,5 e 3 trilhões de dólares anuais até 2030, adicionais aos recursos já investidos, o que seria equivalente a cerca de 6% do PIB global. E a situação econômica mundial, em especial as decorrências da pandemia de COVID-19, vem dificultando a ampliação dos investimentos nesse sentido, o que coloca em risco o alcance das metas mencionadas (OECD, 2020a).

Considerando que o valor mencionado corresponde a menos de 1% dos ativos globais (Credit Suisse, 2021), depreende-se que se trata mais de uma questão de reorientar carteiras de investimento do que de falta de recursos.

Para que essa reorientação ocorra, viabilizando a migração de investimentos em ativos tradicionais para negócios socioambientais, há um desafio significativo de melhorar a percepção de risco desse tipo de investimento, cujo histórico ainda é recente em modelagens que visem retorno financeiro em conjunto com impacto positivo para a sociedade. As chamadas finanças sustentáveis e o investimento de impacto, aos poucos, vem incorporando aspectos ASG (sociais, ambientais e de governança) na lógica dos investimentos. Porém, a velocidade necessária para que uma mudança substantiva ocorra em prazo compatível com a emergência climática e as necessidades sociais precisa ser acelerada.

O conceito de *Blended Finance* vem crescendo dentro dessa perspectiva de acelerar os investimentos socioambientais, sendo entendido como uso de recursos concessionais, também chamados de capital catalítico (subsidiados ou não reembolsáveis), para estimular investimentos comerciais com objetivos de retorno financeiro em busca de alcançar os objetivos de desenvolvimento sustentável, especialmente nos países em desenvolvimento[3].

O capital catalítico, cujas características principais são a "paciência" pelo retorno, a propensão maior a riscos, a disposição para estruturar e capacitar os negócios e a aceitação de retornos baixos ou nulos, e/ou até garantindo eventuais perdas, fornece aos capitais comerciais uma melhor equação de risco e retorno, uma vez que a estruturação dos negócios e eventuais primeiras per-

[1] (Convergence, 2021).

[2] Os ODS foram definidos em 2015 pela ONU e estão organizados em 169 metas relativas a 17 macro objetivos a serem cumpridas em 15 anos (a chamada Agenda 2030).

[3] https://www.oecd.org/dac/financing-sustainable-development/blended-finance-principles/. Tradução própria.

das estarão garantidas pelos parceiros concessionais. Dessa forma, espera-se que os negócios socioambientais possam ser viabilizados por um *blend* entre diferentes tipos de recursos, com diferentes perfis de risco e retorno, equacionando suas necessidades de capital para estabelecimento e crescimento.

Dada a participação de diferentes tipos de capital, é importante a existência de um agente intermediário que promova o alinhamento de interesses entre os diferentes investidores, a aplicação dos recursos de forma tempestiva, o acompanhamento e orientação aos negócios e a medição de seu impacto socioambiental.

De acordo com estudo da Convergence (2021), para o avanço dos valores investidos em estruturas de *Blended Finance* em nível global, ainda há uma agenda extensa de articulação institucional, de fomento ao surgimento de agentes intermediários em quantidade e qualidade para dar conta das necessidades de redução do *gap* de financiamento dos ODS e de melhor comunicação das experiências de *Blended Finance*, que permitam uma aceleração das curvas de aprendizado no tema.

No que diz respeito aos países em desenvolvimento, especialmente no Brasil, a OCDE (OECD, 2020b) indica um papel central para os Bancos Nacionais de Desenvolvimento (BNDs) para o alcance dos objetivos de desenvolvimento sustentável. Apesar da agenda de *Blended Finance* ainda ser incipiente no País, os BNDs e demais instituições de fomento, com o devido mandato político dado por seus governantes, pode favorecer, com a oferta de capital catalítico, a mobilização de recursos privados em grande escala, ampliando assim o potencial de investimento em setores cuja presença dos capitais comerciais ainda é pequena, característica observada nos projetos sociais e ambientais ligados aos ODS.

Considerando o nível de risco ainda percebido em tais perfis de projeto, é natural que, historicamente, os recursos investidos em tais atividades tenham sido, em grande medida, não reembolsáveis. Entretanto, dada a urgência climática e ambiental, para alcançar o investimento necessário para o cumprimento das metas dos ODS, é necessária a mobilização de um volume significativo de recursos, cujas fontes não reembolsáveis, além de não serem suficientes, carecem de características importantes para tornar os investimentos socioambientais também economicamente sustentáveis. Essa tarefa deverá ser endereçada pelos investimentos comerciais, sendo a necessidade do uso de não reembolsáveis, numa estratégia de *Blended Finance*, pensada em uma trajetória descendente.

Dentro desse contexto, a próxima seção apresenta a experiência histórica do BNDES com uso de recursos não reembolsáveis, que culmina, nos anos mais recentes, na formulação de uma chamada pública para apoio, com

recursos concessionais, a estruturas de *Blended Finance* no Brasil, que será detalhada na seção 4 subsequente.

3. Trajetória da atuação socioambiental do BNDES pela ótica dos instrumentos financeiros

Desde 1952, portanto há mais de setenta anos, o Banco Nacional de Desenvolvimento Econômico e Social (BNDES) é um instrumento do Estado Brasileiro cuja missão é prover soluções para as mais diversas necessidades apresentadas no processo de desenvolvimento nacional.

Sua trajetória mostra o apoio, seja com crédito, capital ou serviços não financeiros, a crescente número de temas, desde projetos de infraestrutura de transportes e energia, em seus primórdios, estendendo seu apoio a temas como por exemplo a indústria de base e de consumo, a inovação tecnológica, a exportação, a agricultura, as micro e pequenas empresas, cooperativas e os microempreendedores individuais e empreendimentos de baixa renda.

Originalmente denominado BNDE, em 1982 recebe o S para registrar expressamente sua missão social, reconhecendo-a como parte fundamental para o processo de desenvolvimento nacional. Em 1997, o trabalho experimentado nos 15 anos anteriores se consolida com a criação da Área de Desenvolvimento Social (AS) e a constituição de um Fundo Social próprio, criado a partir de uma parcela dos lucros anuais do Banco, para realização de investimentos sociais de forma não reembolsável[4].

Numa primeira fase do Fundo Social, o apoio foi concedido, principalmente, para ações ligadas aos campos da saúde e educação, e preferencialmente para iniciativas com potencial de se tornarem políticas públicas, o que, em geral, foi feito em parceria com municípios e no âmbito de outras ações estruturantes realizadas pelo poder público local (Neves e Souza, 2011).

A partir de 2003, o foco das ações do Fundo Social passou a ser o apoio a projetos de geração de trabalho e renda, que nos anos seguintes se tornou bastante significativa. Se o primeiro programa nesse sentido, o Programa de Desenvolvimento Local (PDL), ainda na primeira fase do Fundo Social, contratou quatro operações, tendo desembolsado cerca de R$ 14 milhões, de 2003 a 2008 foram contratados 54 projetos de desenvolvimento local, pelo Programa de Investimentos Coletivos (PROINCO) e numa iniciativa de apoio a cooperativas de catadores de materiais recicláveis, alcançando um total de cerca de R$ 60 milhões (Pamplona, 2009).

[4] A primeira fase da atuação social do BNDES foi viabilizada pela gestão, delegada ao Banco, do Finsocial, imposto cobrado pelo governo Federal sobre a renda para apoio a projetos sociais. O Finsocial foi extinto em 1990, tendo o BNDES, por alguns anos, ficado sem fontes regulares de recursos para investimentos sociais.

Para ampliar a escala de atuação, o BNDES aprimorou sua estratégia de parcerias institucionais, se aliando a instituições com capacidade para alavancar seus recursos, ainda que de forma também não reembolsável. No período de 2009 a 2015, as contratações não reembolsáveis para geração de trabalho e renda alcançaram o patamar de R$ 1 bilhão, recursos que foram duplicados por seus parceiros e alcançaram cerca de 1.700 municípios brasileiros, em sua maior parte com índices de desenvolvimento humano (IDH) abaixo da média nacional. O número de projetos apoiados na ponta também saltou de cerca de 80, com a celebração do mesmo número de contratos, cumulativamente contados até 2008, para mais de 1000 projetos apoiados por meio de 150 contratos, também considerando valores acumulados (Pamplona, 2017).

Na temática ambiental, o BNDES atuou eminentemente com projetos de restauração florestal, tendo contratado, no período de 2010 a 2018, cerca de 25 operações no valor total de R$ 70 milhões. Recentemente, em uma estratégia semelhante à realizada no tema de geração de trabalho e renda, foi lançada uma chamada de captação de recursos complementares para restauração florestal, chamado Floresta Viva, onde foram captados recursos não reembolsáveis com mais de 10 parceiros privados para serem igualmente aportados pelo BNDES em projetos de reflorestamento, totalizando a previsão de R$ 700 milhões.

Atualmente, o BNDES ainda disponibiliza, por meio de orçamentos trienais, recursos não reembolsáveis em quatro diferentes Fundos Estatutários, brevemente descritos a seguir.

Fundo Socioambiental (maior abrangência temática) investimentos de caráter social, nas áreas de inclusão produtiva, serviços urbanos, saúde, educação, desportos, justiça, meio ambiente e outras vinculadas ao desenvolvimento regional e social;

Fundo Cultural projetos de preservação e revitalização do Patrimônio Cultural Brasileiro e projetos estruturantes para as cadeias produtivas da Economia da Cultura;

Fundo de Tecnologia (FUNTEC) projetos de P&D nos Institutos de Tecnologia em parceria com empresas, estimulando o desenvolvimento tecnológico e a inovação de interesse estratégico;

Fundo de Estruturação de Projetos (FEP) desenvolvimento de estudos técnicos ou pesquisas, bem como a estruturação de projetos que promovam o desenvolvimento econômico e social do país, seja por meio de prospecção e P&D de projetos ou estruturação de projetos, inclusive com abordagem ASG, que possam orientar a formulação de políticas públicas.

O BNDES também opera fundos que contam com recursos captados junto

a terceiros, possuindo, portanto, natureza híbrida definida por meio dos instrumentos específicos de operacionalização dos referidos fundos, tais como:

Fundo Amazônia voltado a ações de prevenção, monitoramento e combate ao desmatamento, e de promoção da conservação e do uso sustentável das florestas da Amazônia Legal, foi criado em 2008 e é formado por doações do Governo da Noruega, da Petrobras e da República Federal da Alemanha e já soma R$1,9 bilhão em projetos contratados.

Fundo para o Desenvolvimento Regional com Recursos da Desestatização (FRD) criado em 1997, a partir de recursos oriundos do processo de desestatização da então estatal Companhia Vale do Rio Doce – CVRD.

Nos últimos 15 anos, o BNDES desembolsou cerca de R$ 3,3 bilhões em doações, por meio dos quatro Fundos Estatutários não reembolsáveis, o que, em conjunto com doações de terceiros, contribuiu para totalizar os cerca de R$ 10,2 bilhões aplicados em cerca de 1.550 programas/projetos socioambientais, distribuídos em todas as regiões do território nacional.

A seguir, é mostrada a evolução de desembolsos de recursos não reembolsáveis dos Fundos Estatutários e Fundos Híbridos listados anteriormente. Nota-se que houve uma evolução crescente de liberações de recursos não reembolsáveis até 2014, quando o BNDES registrou desembolso de R$ 483 milhões para Fundos Estatutários e R$ 201 milhões para os Fundos Híbridos.

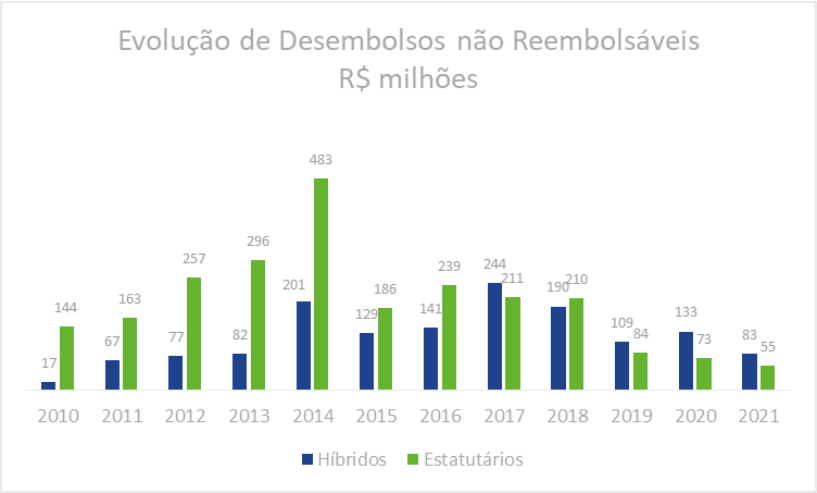
A partir do final de 2014, os efeitos da crise econômica passaram a ser sentidos, o que se agravou significativamente nos anos seguintes. O PIB caiu 3,5% em 2015 e 3,3% em 2016, registrando queda de investimentos em vários setores, inclusive a queda de investimentos não reembolsáveis.

Em 2017 e em quase todos os anos subsequentes, outra tendência interessante que pode ser observada é que os desembolsos de recursos para os Fundos com recursos de terceiros (Fundo Amazônia e FRD) passaram a superar os referentes aos Fundos Estatutários, o que demonstra o papel crescente dos recursos captados junto a terceiros para complementar as necessidades de investimentos de caráter socioambiental.

As operações com recursos não reembolsáveis representam um custo operacional alto para o Banco, principalmente por suas particularidades de acompanhamento. Por isso, são crescentes as discussões sobre a necessidade de revisão dos processos relacionados aos não reembolsáveis e da proposição de estruturas inovadoras para o apoio do ecossistema do setor social.

Ao longo da trajetória de atuação socioambiental do BNDES apresentada acima, também foram realizadas análises estratégicas complementares que apontavam para algumas possibilidades de aprimoramento da atuação com recursos não reembolsáveis. Uma delas foi a estruturação de plataformas de

Figura 1
Evolução do desembolso de recursos não reembolsáveis pelo BNDES nos anos recentes



Fonte: BNDES.

articulação que congregassem diversos parceiros e fossem operacionalizadas por instituições intermediárias especializadas, com o propósito específico de zelar pela boa aplicação dos recursos e harmonizar as diversas especificidades operacionais de cada instituição. O Programa Floresta Viva, mencionado acima, observou tais recomendações.

Um outro apontamento colocado em debate desde então era a necessidade de aprimorar a capacidade dos recursos não reembolsáveis de promover sustentabilidade econômica nos projetos apoiados, considerado como fundamental para viabilizar o acesso ao crédito e investimento tradicionais e o alcance da independência das instituições dos recursos não reembolsáveis, bem como a consequente expansão do seu alcance (Pamplona, 2017).

Esse debate interno se mostrou bem alinhado com a visão do setor privado em relação ao papel das doações, que veio crescentemente dando lugar a formulações ligadas à filantropia estratégica (Deboni e Aloi, 2019), ao conceito de "doações recicláveis" (usando os recursos não reembolsáveis para o doador mas fazendo com que seja cobrado, em alguma medida dos projetos apoiados, de forma pedagógica e com vistas a constituir instrumentos de crédito autônomo no médio e longo prazo) e ao investimento de impacto socioambiental, que congrega propósito com retorno financeiro.

Todos os conceitos abordados trazem como pano de fundo a ideia do ca-

pital paciente, que compreende a necessidade de estruturação prévia dos projetos socioambientais para que possam se tornar, ao longo do tempo, economicamente sustentáveis. É compreensível que os investidores privados tradicionais ainda tenham dificuldades para ampliar o horizonte temporal das suas expectativas de retorno financeiro e, da mesma forma, projetos que necessitem de maior tempo de maturação tenham uma maior percepção de risco.

Essa experiência com o uso de recursos não reembolsáveis, e os debates para alavancar seu impacto e atrair mais parceiros e recursos privados, culminaram, nos anos recentes, em algumas inovações, ainda em curso, no sentido de ampliar a efetividade de sua atuação socioambiental.

Durante o ano de 2020 duas frentes podem ser destacadas: i. a revisão interna da governança e procedimentos para uso dos recursos não reembolsáveis, incluindo a prototipagem de novas alternativas, como uma espécie de "Sandbox"[5]; e ii. um estudo sobre alternativas de captação de recursos privados para alavancar projetos com impacto socioambiental, considerando pesquisas junto ao mercado (institutos, fundações e empresas).

Estas frentes, além de possibilitar ao BNDES iniciar um trabalho transversal com diversas equipes internas, permitiram identificar junto ao mercado que, além das temáticas setoriais e territoriais, governança e *accountability* seriam elementos-chave para a construção de novos modelos de atuação, sobretudo por surgirem como qualificadores de valor de uma eventual parceria com o BNDES.

4. Jornada *Blended Finance* no BNDES

Como visto na seção anterior, a jornada começou com a montagem de um grupo transversal, liderado pela Área de Gestão Socioambiental, agregando técnicos de outras áreas, com expertises diferenciadas e responsáveis por mercado de capitais, processos, planejamento, finanças e jurídico.

Foi criada uma força tarefa em meados de 2021 e utilizado um sistema interno para controle das fases de todo o processo, gerenciado pela equipe do Escritório de Projetos do BNDES (no inglês, o já conhecido PMO[6]), que auxiliou os responsáveis pela condução dos trabalhos.

Ainda durante a fase inicial de constituição do grupo, foi identificada a necessidade de construção de um arcabouço regulatório mínimo para garantir o uso adequado dos recursos não reembolsáveis no contexto de uma abordagem de *Blended Finance* (considerando suas especificidades, uma vez que,

[5] Sandbox é um termo utilizado para caracterizar um ambiente normativo isolado para a realização de experiências piloto, no sentido de fomentar inovações de maneira controlada.

[6] PMO – Project Management Office. Simplificadamente, é o setor responsável por implementar e garantir a manutenção dos padrões de Gerenciamento de Projetos adotados pelas organizações.

na prática, são doações realizadas a entidades com encargos como contrapartida). Essa definição foi fundamental para a construção da nova abordagem, bem como do processo necessário para sua elaboração.

O projeto foi pensado em quatro frentes interdependentes e, por vezes, concomitantes: i. desenvolvimento do produto e processos; ii. relacionamento com *stakeholders*; iii. comunicação; e iv. Observatório.

De forma resumida, na primeira frente, de desenvolvimento do produto e processo, optou-se por não realizar apenas um piloto, mas sim desenhar um regulamento específico para que o BNDES pudesse aplicar recursos em estruturas híbridas de financiamento. O uso tradicional dos não reembolsáveis pelo Banco era voltado majoritariamente para entidades sem fins lucrativos, o que limitaria o uso de estruturas que buscam justamente conciliar capitais concessionais e comerciais, para alavancar o impacto, como no caso do *Blended Finance*.

No caso em questão, a nova abordagem deveria ser flexível e buscar como objetivo principal o teste de instrumentos e estruturas financeiras inovadoras. Além desta premissa inicial, o grupo buscou as melhores práticas internacionais, como os princípios de *Blended Finance* da OCDE[7] e de outras Instituições Financeiras de Desenvolvimento (DFI), como o IFC[8], adaptando-os ao contexto do País e ao papel do BNDES.

Desse estudo resultou uma gama de objetivos paralelos que a nova abordagem deveria buscar, como alavancagem de recursos de terceiros, impacto socioambiental positivo, apoio a iniciativas inovadoras e escaláveis e monitoramento e avaliação de impacto (M&A), visto como fundamental para prestação de contas e aferição da efetividade da iniciativa.

Um dos objetivos mais importantes, que permeou o processo desde o início, foi a visão de que seria importante fomentar o desenvolvimento de todo o ecossistema, e que os agentes intermediários, que ficariam responsáveis pela gestão da captação de recursos (concessionais e comerciais) e pela implementação dos projetos na ponta, de forma análoga ao papel de gestores de fundos em mercado de capitais, teriam um papel muito importante e diferenciado, ajudando a profissionalizar e fortalecer agentes de mercado que muitas vezes operam com baixa governança e pouca capacidade de prestação de contas.

Em paralelo à construção do produto, o relacionamento com diferentes *stakeholders* foi fundamental para entender a necessidade do mercado e qual seria o papel do BNDES. Destaca-se a participação no Laboratório de Inova-

[7](OECD, 2022)
[8](International Finance Corporation (IFC), 2021).

ção Financeira (LAB)[9], que em um de seus Grupos de Trabalho (GT), vinha se dedicando a estudar o tema, e que, além de disseminação dos conceitos de *Blended Finance* no País, apoiou alguns pilotos de instituições públicas e privadas, incluindo a iniciativa do BNDES.

O apoio do LAB foi muito importante nos debates e na conexão com diversos atores, públicos e privados, bem como órgãos de controle, como o Tribunal de Contas da União (TCU), que participou de encontros com o LAB para entendimento dos conceitos básicos de *Blended Finance*.

Esta frente contou ainda com uma extensa escuta de mercado, em quase sessenta reuniões realizadas com cerca de quarenta instituições, dentre gestores, intermediários, investidores e parceiros potenciais, preponderantemente atuantes no Segundo e Terceiro Setores. Esta escuta alimentou ao longo do processo a frente de elaboração do produto.

Apoiando ambas as frentes descritas, interna e externamente, estava a de comunicação, fundamental para a troca de informações e transparência com os diferentes atores envolvidos no ecossistema, e oportuna para a manutenção de relacionamentos e eventuais parcerias futuras. A participação do Banco em fóruns de discussão e conversas com entidades como GIFE[10] - que congrega institutos, fundações e empresas e tem forte apelo em catalisar o investimento social privado e filantropia, e Latimpacto[11] - instituição focada em mobilizar capital para impacto, dentre outros, ajudou a pavimentar o caminho e construir o que viria a ser a solução financeira em *Blended Finance* do BNDES.

A quarta e última frente, do Observatório, foi postergada, pois demandaria uma articulação maior com o mercado e massa crítica para a realização dos trabalhos, o que a equipe entendeu que só seria possível com o lançamento da primeira chamada pública para contratação de estruturas em *Blended Finance*.

Assim, em dezembro de 2021 foi criado o BNDES Fundo *Blended Finance* (BFBF), com o objetivo de dotar o BNDES de instrumental e recursos para o apoio a soluções de *Blended Finance*, visando tanto o aprendizado institucional do Banco quanto o desenvolvimento do mercado brasileiro e o fortalecimento do ecossistema.

Em resumo, a criação do Fundo buscava estabelecer um lócus de inovação e previa que os recursos não reembolsáveis seriam aplicados em caráter

[9] (Laboratório de Inovação Financeira, 2022). Trata-se de um fórum de interação multissetorial e um espaço de diálogo público privado para a promoção da inovação e das finanças sustentáveis no país. Uma parceria iniciada por ABDE, CVM, BID e GIZ, e que reúne centenas de representantes do governo e da sociedade.

[10] https://gife.org.br/

[11] https://www.latimpacto.org/?lang=pt

piloto, experimental e inovador, com objetivo de desenvolver novos modelos e instrumentos financeiros, utilizando desenhos híbridos ou combinados ("*Blended Finance*"). A partir das lições aprendidas pretendia-se replicar e escalar as estruturas mais adequados ao Banco.

A forma de apoio dos recursos do BFBF seria exclusivamente por meio de chamadas públicas para a seleção de estruturas *blended*, a serem conduzidas por um intermediário, também chamado de estruturador, responsável por desenvolver os projetos e realizar a captação e gestão de recursos, utilizando desenhos híbridos ou combinados de instrumentos financeiros, agregando governança e adequada prestação de contas.

Destaca-se que o regulamento do BFBF buscou ser o mais flexível possível, delegando para os editais a serem lançados, quando das chamadas públicas, um detalhamento maior quanto aos temas escolhidos e seus objetivos específicos, diretrizes e critérios de priorização.

Com a solução financeira concluída, iniciou-se a construção do primeiro edital. A Área de Gestão Socioambiental, onde nasceu a iniciativa, era a maior interessada em tocar projetos do gênero, em função de suas atribuições. Outra candidata natural era a Área responsável pela agenda de inovação no BNDES, ligada às atividades da indústria.

A comunicação foi novamente um elemento fundamental, tanto com as equipes internas, para definição do escopo da chamada e dos seus critérios, quanto para fora, tendo sido realizadas, da mesma forma que na etapa anterior, reuniões para testar os conceitos junto a uma gama de *stakeholders*, principalmente estruturadores e gestores, que serviram para ajustes e validações importantes no edital. Esta etapa foi importante também para buscar maximizar o alcance da Seleção Pública, chamando a atenção de potenciais parceiros para composição futura do *funding* dos projetos.

4.1 O Primeiro Edital de Seleção do BNDES Fundo *Blended Finance* e seus impactos

Dando sequência à criação do BFBF, em maio de 2022 o BNDES lançou o primeiro edital para seleção pública de estruturas financeiras híbridas, num valor total de até R$ 90 milhões (noventa milhões de Reais). Estes recursos deveriam ser utilizados como capital catalítico nas estruturas propostas, estando limitados a R$ 30 milhões (trinta milhões de Reais) por estruturador, para garantir acesso a diferentes agentes de mercado e evitar a concentração.

As propostas deveriam atender aos objetivos gerais já descritos anteriormente para a abordagem e as estruturas deveriam promover projetos com impacto social e ambiental positivo em uma das seguintes vertentes: Bioeconomia Florestal, Desenvolvimento Urbano e Economia Circular.

Foram realizados webinários para divulgação dos conceitos e detalhes do edital juntos aos potenciais participantes, além da prorrogação do prazo inicial para submissão de propostas, buscando dar tempo ao mercado para se adaptar a esta iniciativa inovadora.

O processo seletivo mostrou-se bastante complexo, não apenas por contar com diferentes equipes envolvidas, que seriam as responsáveis pela contratação e acompanhamento das estruturas após a seleção, como por se tratar de uma inovação aberta, onde o BNDES deu apenas diretrizes gerais para as temáticas, ficando o mercado livre para propor diferentes desenhos de estruturas e projetos.

As diferentes equipes e graus de conhecimento dos conceitos de *Blended Finance* deixaram clara a importância de se manter uma estrutura mínima focada na construção da ferramenta em si, bem como pelo nivelamento do conhecimento e uniformização do processo. Todas as etapas foram conduzidas pelo chamado núcleo duro da iniciativa, funcionários originados da Área de Gestão Socioambiental, que ficaram dedicados integralmente ao projeto e que interagiram com os diversos clientes internos.

A escolha das estruturas em si foi um grande desafio, seja pela quantidade de propostas protocoladas (cinquenta), quanto pela qualidade e diversidade das estruturas. O edital ocorreu em três etapas, tendo sido as duas primeiras conduzidas pelas equipes internas, para triagem das propostas, e a terceira realizada por um Comitê de Seleção formado por especialistas internos e com membros externos com papel consultivo. Participaram deste último representantes do Banco Interamericano de Desenvolvimento (BID) e do Programa das Nações Unidas para o Desenvolvimento (PNUD), que agregaram diferentes visões e expertises, robustecendo sobremaneira o processo seletivo.

No final de novembro de 2021 o BNDES divulgou em sua página na internet[12] a lista final das onze propostas selecionadas, por ordem de classificação. Essas ficarão em um cadastro de reserva e serão chamados pelas equipes específicas do BNDES, seguindo aquela ordem, para detalhamento das propostas e contratação.

Ainda que haja um grande caminho a percorrer, dado seu ineditismo, alguns números dão uma ideia do potencial da iniciativa, bem como de seus desafios.

O primeiro deles é a limitação orçamentária, uma vez que as onze estruturas selecionadas demandaram inicialmente R$ 246 milhões (duzentos e quarenta e seis milhões de Reais), para R$ 90 milhões (noventa milhões de Reais) alocados inicialmente. Algumas alternativas serão discutidas entre os proponentes e as equipes do BNDES, visando ao atendimento do maior nú-

[12] http://www.bndes.gov.br/blendedfinance

mero possível de estruturas, dentre elas a busca de parceiros, filantropos e investidores, para suprir a lacuna orçamentária.

Outros desafios vislumbrados por ora são a própria contratação de diferentes estruturas e seu acompanhamento futuro pelas equipes do BNDES. Este último tema vem sendo discutido também no âmbito do LAB, que deve propor em breve um framework padrão para acompanhamento de estruturas em *Blended Finance* pelos diversos agentes interessados na agenda, o que pode auxiliar o trabalho interno do Banco, inclusive quanto à sua uniformização, uma vez que o acompanhamento deverá ocorrer de forma descentralizada.

Já com relação ao potencial de *Blended Finance* no País, as cinquenta propostas enviadas, oriundas de uma variada gama de proponentes, solicitaram recursos não reembolsáveis de mais de R$ 900 milhões (novecentos milhões de reais) de capital concessional para implementação de estruturas e projetos com relevante impacto socioambiental, valor dez vezes maior que o alocado no orçamento inicial pelo BNDES. Considerando que foram priorizadas apenas três vertentes temáticas, pode se ter uma estimativa inicial do potencial de uso da ferramenta *blended,* tendo em vista uma alavancagem média dos projetos de cerca de cinco vezes[13].

Além disso, a diversidade de estruturas e instrumentos inovadores apresentados, tais como CRIs, CRAs, FIDCs, Fundos Garantidores e Filantrópicos, FIPs e FIIs aumentam a possibilidade de uso de capital catalítico para atrair capitais privados.

Sendo o Brasil um país em desenvolvimento, com diversas mazelas socioambientais e *gaps* de financiamento para o desenvolvimento sustentável e atingimento dos ODS, pode-se imaginar o potencial do uso da ferramenta *Blended Finance* e sua extensão a temas como saúde, educação, geração de emprego e inclusão produtiva, saneamento e inovação, dentre outros.

5. Considerações finais

O presente artigo procurou demonstrar o trabalho do BNDES na promoção do desenvolvimento econômico sustentável, desde a contextualização do seu histórico de atuação socioambiental, passando pela evolução vista globalmente e culminando no desenvolvimento de um instrumento financeiro inovador no País, o *Blended Finance*, com objetivo de atrair e alavancar capital privado e causar mais impacto socioambiental positivo.

Esta jornada só foi possível com o apoio da Alta Administração, ao segregar parte da equipe e conceder-lhe mandato específico para desenvolvimento

[13] Extrapolando a alavancagem média das onze propostas selecionadas, que demandaram R$ 246 milhões para projetos com impacto socioambiental no valor total de R$ 1,240 bilhão.

de uma nova abordagem, transversal e colaborativa, como o próprio nome "*blended*" sugere.

Fundamental também para seu sucesso foi poder contar com diversos técnicos, de diferentes perfis, expertises e departamentos, para ajudar a quebrar silos, mudar a cultura vigente e testar inovações.

Há ainda no horizonte diversos desafios a serem enfrentados, como a implementação dos projetos e fortalecimento do ecossistema, além do acompanhamento, monitoramento e avaliação dos impactos das estruturas, que poderiam ser consolidados em estruturas como um observatório dedicado ao tema, para que não se perca a visão do todo e dar continuidade ao fomento.

Como primeiras lições aprendidas, a disseminação de conhecimento, centralização e especialização de equipes dedicadas ao tema, além de ampla escuta de mercado, apoiados por uma estrutura de divulgação estratégica, surgem como aprendizados positivos na construção de iniciativas inovadoras e replicáveis.

Ao buscar fomentar o ecossistema, não só pela formatação da chamada, bem como pela divulgação e apoio à agenda *Blended Finance* no País, o BNDES obteve um *feedback* positivo de ter mobilizado diversos agentes de mercado para este tipo de solução, que pode ser seguida e multiplicada pelo Sistema Nacional de Fomento, ampliando sobremaneira seu alcance e impacto.

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