

Green lemons: overcoming adverse selection in the green bond market*

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Abstract

As the green bond market continues to develop and assume a critical role as a post-pandemic vehicle for supporting a balanced economic rebuild and credible transition efforts, policymakers must reassess the current disclosure regime. This paper derives findings from Bayesian games to demonstrate that the prevailing labelling regime for green bonds is susceptible to the adverse selection problem; due to informational asymmetries, allocative inefficiencies arising from capital misallocation to inherently “non-green” bonds may ensue. To prevent the erosion of confidence in the market segment and support the potential of impact finance instruments to affect positive social and environmental change, this paper draws on established game theory frameworks to inform recommendations for policy-led solutions to uphold the market’s credibility. These recommendations concern the integration of a regulatory infrastructure, a centralized ongoing audit under an “exogenously costly” regime and the introduction of a clearer course for legal recourse against issuers that mislabel bonds.

Keywords: green bonds, Bayesian equilibria, voluntary disclosure, adverse selection

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1. Introduction

As a response to the climate free-rider problem, among other inextinguishable environmental and social issues, the impact finance market introduces a private sector-led solution that serves to internalize “externalities and adjust risk perceptions” (G20, 2016, p. 3), partially bypassing due government intervention.¹

Green bonds are unique instruments for financing sustainable development that will play a critical role in aligning economies with the Paris Agreement (UNFCCC, 2015). By virtue of issuers’ *use-of-proceeds pledges*,² investors obtain project-level positive impact exposure while maintaining issuer-level credit risk exposure. Research finds that some investors will apprehensively pay a premium for green bonds relative to their conventional curve – a phenomenon in economic and asset-pricing theory (Bakshi and Preclaw, 2015; Henide and Meyer, 2020) – incentivizing issuers with the prospect of capital arbitrage and a lower resulting cost of capital.

The incumbent labelling regime for green bonds, however, is susceptible to greenwashing. The result may be a source of inefficient capital allocation, eroding confidence in the green bond market and reducing the segment’s potential in affecting positive outcomes.

In pursuit of an allocatively efficient green bond market, optimizing the impact of each unit of investment, this paper contributes a theoretical framework anchored in Bayesian game theory for assessing market efficiency. Inferences from the games are discussed and practical recommendations for policymakers are derived from them; the inferences are also used to assess the proposed European Union Green Bond Standard (EU GBS) (European Commission, 2021).

The paper begins by discussing the contextual background and then characterizes the current regime, relating it to the Akerlof (1970) setting, the market for “lemons”, where the adverse selection problem arises as a result of asymmetric information between buyers and sellers. Once the notation and scaffolding for the Bayesian game are established, the paper identifies the inefficiencies of the “free voluntary disclosure” setting (Akerlof, 1970; Crawford and Sobel, 1982), which resembles the current regime. In pursuit of perfect allocative efficiency, the paper layers further features onto the Bayesian game, invoking “truthful disclosure” (Milgrom, 1981) and introducing “exogenously costly disclosure” (Verrecchia, 1983). It concludes by articulating the vulnerabilities of the current regime and proposing policy-led recommendations. These recommendations are further developed and related to the EU GBS, assuming that the voluntary label will operate in parallel with

¹ The impact finance segment consists of green and social finance. See ICMA (2020, p. 6).

² The hypothecation of issuance proceeds in legal documentation, where projects intended for (re)financing are outlined.

but not supersede the International Capital Markets Association (ICMA) Green Bond Principles, the most common voluntary framework and outline for best practices referenced in the issuance of green bonds globally. The paper outlines the implications of the recommendations on market dynamics and then the implications for corporate issuers of the EU GBS. Finally, the paper comments on the nature of striving for perfect allocative efficiency through policy and highlights a critical trade-off, the inclusivity of market participation. It questions the preferable balance between perfect efficiency and market inclusivity, and the impact of manipulating market participation standards on the systemic “green ambition” of issuers.

1.1. Historical development of the green bond market

In its simplest form, a green bond, as per the ICMA principles, contains four key components: (i) a pledge of proceeds – issuers commit to hypothecate raised proceeds to finance and/or refinance what ICMA terms “eligible activities” with clear environmental benefits; (ii) a process for project evaluation and selection – issuers must clearly communicate their objectives and their approach for selecting how the given project(s) fit within the scope of the eligible project categories outlined by ICMA; (iii) proceeds management – the outstanding balance of the raised proceeds, which is in theory ring-fenced for investment in eligible activities, is periodically adjusted on the basis of the to-date allocations of the proceeds; and (iv) reporting.

In this paper, “green bond” refers to standard green use-of-proceeds bonds (ICMA, 2021, p. 8). It is not interchangeable with “green project bond”, where recourse is to the project rather than the issuer, or “green revenue bond”. Standard green use-of-proceeds bonds are unique in their exposure, providing credit risk exposure to the issuer but direct and measurable positive impact exposure to the reference project(s); project impact is outlined by issuers that engage in transparent, periodical post-issuance reporting, as recommended by ICMA (table 1), which reflects information on the use of proceeds until there remains no outstanding balance to allocate.

The first sustainability-themed bond was issued by the International Finance Facility for Immunisation (IFFIm) in 2006 on behalf of Gavi, the Vaccine Alliance, and led by Goldman Sachs. The bond targeted positive social outcomes through facilitating a large-scale vaccination programme across emerging markets. Announced by Gordon Brown, the then sitting British Chancellor of the Exchequer, the \$1 billion of proceeds were pledged to support the immunization strategy for over half a billion impoverished children, across more than 60 nations, over a decade. Through the life of the issuance programme, IFFIm accessed \$6 billion in capital from 10 sovereign governments exclusively for financing Gavi's vaccination strategy.

Table 1. Comparing the key features of green and conventional bonds

Key features	Green	Conventional
Credit risk	Issuer	Issuer
Use of proceeds	Eligible projects	Unspecified
Disclosure of proportion of proceeds used for refinancing	Recommended	No
External review	Recommended	No
Publication of external review	Recommended	No
Social safeguards	Recommended	No
Impact monitoring and reporting	Recommended	No

Source: Based on ICMA (2021).

IFFIm has since been instrumental in shaping the ICMA Social Bond Principles and has adopted the voluntary framework. Together, the Green Bond Principles, the Social Bond Principles and the Sustainability Bond Guidelines published by ICMA form the three key pillars of the impact finance market. For simplicity, green bonds are referred to throughout the paper, but the inferences are applicable to the broader body of use-of-proceeds bonds in the impact finance market.

The green bond market emerged with issuances by multilateral banks, sub-sovereign agencies, and supranational institutions. Among the original adopters were the World Bank (the International Bank for Reconstruction and Development), the International Finance Corporation, the European Investment Bank, the European Bank for Reconstruction and Development, the African Development Bank, the Asian Development Bank and the Nordic Investment Bank. This context offers insight into the forthcoming discussion on the bona fide nature of the issuance market and the perceived lack of regulatory oversight. The Green Bond Principles are recommendations, but there is no central supervisory body that ensures the alignment of label adopters to the standards, penalizing violators accordingly, and the legal grounds for seeking a resolution against a label adopter that is not aligned with the standards are scant. To draw a parallel with accounting, for example, a developed ecosystem consists of standard-setters as well as regulators and auditors that operate on an ongoing basis, in which the latter evaluate mandated minimum disclosures, occurring during a periodical reporting schedule. The green bond market lacks both mandated ongoing audit and minimum disclosures, as well as a formal regulator to oversee and enforce the standards designed by the standard-setters. This is, though, a reductionist description that negates the multi-layered reality of accounting systems that include

regulators, monitoring entities and supervisors. Hence, this paper maintains that in its current form, the green bond market is subject to a perceived lack of regulatory oversight and a resulting lack of credibility in the enforcement mechanism.

1.2. Rationalizing the role of the green bond market

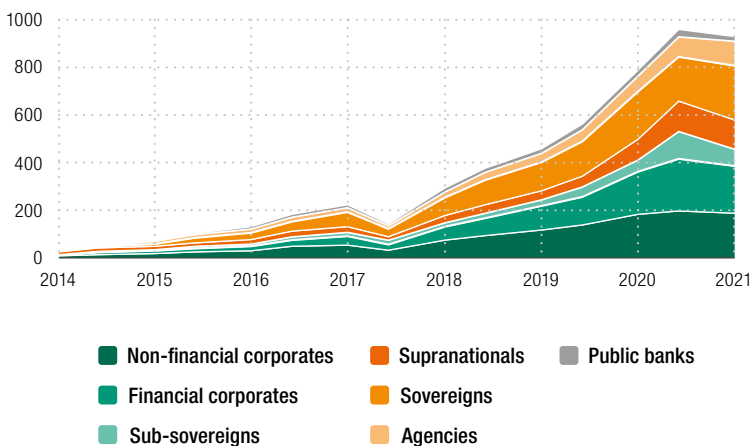
The existence and perceived success of green bonds poses a philosophical challenge to traditional economic theory on the role of organizations and the behaviour of rational investors. The green bond market offers a partial bypass to due government intervention, proposing a private sector-focused solution to the climate free-rider problem, and some investors will apprehensively pay a “greenium”, a green pricing premium, for a green bond with cash flows identical to a non-green equivalent (Bakshi and Preclaw, 2015, p. 2; Henide and Meyer, 2020, p. 7).

By paying a premium relative to an issuer’s non-green curve, holders of a green bond do not acquire any additional or superior claims, and they are not the residual claimants of the positive externalities; investors willingly pay a premium for a green bond, which produces an identical stream of cash flows – when held to maturity – to a non-green bond. Therein, investors incur an additional opportunity cost, but they do so cognizant that they are supporting the (re)financing of debt which will, *prima facie*, support the generation of some social and/or environmental benefit. This trade-off is referred to as the “cost of capital argument” (Flammer, 2021, p. 502). Investors’ opportunity cost is issuers’ potential cost of capital reduction; issuers of green bonds can look forward to the potential of reducing their cost of capital (Flammer, 2021). As such, observing or preserving the green bond pricing premium can be seen to be observing or preserving the economic incentive for issuers to engage in “debt greening”. Aside from the pricing premium of green bonds relative to their respective non-green curves, the cost of capital benefits relate additionally to the potential of a halo effect, by which issuers of green bonds observe a tightening in their non-green curves, thus lowering the potential cost of their non-green debt financing.

Furthermore, issuers can increase the saturation of sustainability-conscious investors in their stakeholder base (Flammer, 2021). The marginal sustainability-conscious investor is found to have a longer investment horizon in the aggregate (Baker et al., 2018; Flammer, 2021), providing longer-term orientation and “stickiness”. A greater degree of investor stickiness can be supportive of price stability throughout the credit cycle. Indeed, Ramel and Michaelsen (2020) find anecdotal evidence for green bond outperformance in “risk-off” periods – characteristically more volatile market environments in which investors tilt away from higher-risk and towards lower-risk investments. The anecdotal evidence noted by Ramel and Michaelsen (2020) refers to the outperformance of green bonds during the pandemic-induced sell-off.

As the market develops (figure 1), incremental penetration is dependent on – or constrained by – the credibility of the green bond label. Participation has drawn interest beyond the initial group of public institutions, multilateral development banks, agencies and supranationals, attracting the interest of profit-seeking corporations. With the broad-based growth of the market, the deficit in the surrounding regulatory infrastructure and the resulting perceived lack of credible enforcement have prompted challenges from investors that fear that some issuers of green bonds may be engaging in greenwashing and that some issuances of green bonds are merely labelling exercises, unaccompanied by appropriate capital allocation actions. Upholding and bolstering confidence in this financing segment is key to ensuring that it is used effectively to support a balanced economic transition; a laissez-faire bona fide approach may have been sufficient while the green bond label was being established as a financing concept among non-profit-seeking public institutions, but policymakers should demonstrate haste in reacting to the development of the market and safeguarding it from the potentially misaligned incentives of value-maximizing issuers. Reinforcing the market is critical to maximizing its potential as a source of critical development finance and preserving it as an instrument for accelerating credible transitions. Reforming the market in pursuit of perfect allocation efficiency requires pivoting away from standards that are built on recommended best practices and relying instead on regulations and mandated minimum requirements.

Figure 1. Impact finance market value by segment, 2014–2021 (\$ billion)



Source: Based on IHS Markit data.

Note: Capturing all rated EUR, USD, GBP and CAD-denominated issuances larger than 250 million (300 million for CAD) in local currency, with a minimum original maturity of 18 months.

As this paper explores, under a voluntary disclosure regime, in which issuers are unencumbered by any costs when disclosing falsehoods, there exists an incentive to (mis)label a bond as green, given the opportunity to send a signal to stakeholders that ultimately yields benefits in the capital markets and enhances broader social perceptions, although the latter remains out of the scope of this paper. The regime in focus is identical in nature to the current labelling regime, which is unregulated and can be virtually costless, depending on the approach of the issuer.

The issue with this regime is the conception of the adverse selection setting (Akerlof, 1970), which facilitates the misallocation of economic resources through the best responses of rational investors, given their observations. This can erode confidence in this market segment. This paper considers Bayesian equilibria in different settings, from the lens of academic frameworks concerning auction markets and firm disclosure, developed and refined by Crawford and Sobel (1982), Milgrom (1981), Jung and Kwon (1988), Myers and Majluf (1984) and Verrecchia (1983). It evaluates the problem of free disclosure, makes inferences and proposes policy-led solutions to overcome potential issues of adverse selection. The focus of the recommendations in this paper is on rational profit-seeking, value-maximizing corporate issuers in the primary market.

In particular, this paper finds grounding in Bayesian game theory to support a top-down pivot of the market regime to one that is exogenously costly for issuers that wish to label their bonds as green. In addition, it rationalizes, from game theory inferences, the integration of a regulatory infrastructure and centralized ongoing audit to serve as an oversight mechanism for the issuance of self-labelled green bonds and the management of their proceeds, as well as a clearer course for legal recourse against issuers that mislabel bonds. This paper proposes that punitive measures for issuers found to mislabel their bonds – greenwashing, by extension – should carry a sufficiently costly deterrent to form an economic disincentive, preventing the (mis)labelling of inherently non-green bonds as green.

1.3. Green bonds in a post-pandemic world

As cumulative issuance of green bonds has crossed the \$1 trillion mark, the green bond market is becoming systemically ingrained. Forecasts from Moody's suggest another record on the horizon for historical annual bond issuance record (\$650 billion) (Environmental Finance, 2021, p.14). The onset of the pandemic saw a broad contribution to the academic corpus on the pandemic as a catalyst for a sustainable transition, which was echoed by policymakers and leaders globally; "build back better" became a slogan adopted by world leaders on both sides of the Atlantic Ocean.

When executed aptly, the targeted, measurable, forward-looking and project-specific nature of green bonds renders them an ideal, directed, instrument for financing positively impactful projects, aligned with science-based targets.

The impact finance market critically provides not only a process for mitigating objectionable activity but for investing in facilitative green or greening activity. Furthermore, it is an approach that is more concerned with the future intentions of issuers rather than their sustainability profiles, which derive from historical decisions and can be inequitably tainted by the structural (dis)advantages of an issuer, given their geography or primary activity, *inter alia*. Incentivizing future impact and explicitly tethering proceeds to projects provides a greater degree of transparency and foresight for stakeholders over the trajectory of issuer activity. In a post-pandemic world focused on delivering credible transitions, the green bond market can be a powerful tool in the investment ecosystem for influencing social and economic realignment, in line with ambitious goals such as those set out in the Paris Agreement (UNFCCC, 2015).

Given the expected importance of the role of the green bond market in supporting the financing of a green transition, the findings and resulting recommendations of this paper are contextually relevant. The recent developments in the EU GBS are also referenced, compared and contrasted with the recommendations deduced from Bayesian games. Furthermore, the European Central Bank and the Bank of England recently solicited feedback regarding the greening of their corporate bond purchasing schemes; ensuring that the market infrastructure is reliable will form a constructive basis for material engagement, particularly by public institutions. This further emphasizes the relevance of the findings and the recommendations of the paper, which are motivated by a desire to uphold confidence in the market and improve allocative efficiency.

2. The current labelling regime for green bonds

Under the prevailing conditions, an issuer of a green bond following a common international standard typically does so by self-labelling a bond as green and integrating the associated language in the bond's prospectus, offering circular and/or final terms documentation. The language typically expresses an issuer's intentions and alignment through a use-of-proceeds pledge.³ Green self-labelling is also commonly accompanied by a green bond framework, which is a more comprehensive document, detailing topics such as the process for evaluating eligible projects, management of and reporting on the allocation of proceeds, alignment with international standards (which is not limited to specific green bond standards) and governance of the green financing process.

³ Although use of proceeds may be legally integrated in an issuer's marketing documentation, the principle of *caveat emptor* prevails: issuers may equivocate liability through the structuring of their legal language, commonly explicitly negating any responsibility for the allocation of proceeds outside of the pledged eligible project set. This is one indication of the perceived lack of credible legal recourse for investors in cases of greenwashing.

The language of a green bond framework is informed by and usually seeks to fulfil the guidance and principles set out by international standard-setters but is not legally bound by them.⁴ Such principles and guidelines are recommendations of best practices, hence the market foundations are *bona fide*, rather than *lex scripta* (written law), in nature. There is a perceived deficit in the oversight infrastructure, with negligible legal recourse or remedy for buyers of green-labelled but inherently non-green bonds. The use of the green label and the subsequent management of proceeds are guided by voluntary principles and are unregulated; the current *laissez-faire* labelling regime relies on the market's self-maintenance and internalization of bond "greenness".

As a partial solution to the credibility problem, some issuers undergo some voluntary form of pre-issuance and post-issuance green audit, in which they solicit external certification. Pre-issuance, issuers may opt for a second-party opinion, third-party assurance or a green bond rating. Post-issuance, they may commission an assurance report or verification, alongside their impact reporting. Both pre-issuance and post-issuance external certification paths entail fees. An external review can be publicized as a third-party attestation to the perceived quality (greenness) of a green bond issuance, or simply alignment. Third-party assurance indicates alignment – to major international standards, for example. Deschryver and De Mariz (2020) find survey evidence of investors relying on external certification, auditing or expertise in finding comfort that a green bond follows best practices, more so than through investors conducting their own due diligence and following internal guidelines. ICMA currently publishes on its website a list of 23 green bond external reviewers that have "contributed to, and confirmed that they will voluntarily align with the Guidelines consistent with any regulatory obligations".⁵ Despite its perceived importance to the market architecture and to upholding investor confidence, the external review process (in particular, by second-party opinion providers) remains decentralized and unregulated; ICMA's disclaimer about the list advises that "ICMA has not investigated or confirmed compliance by the external reviewers with the Guidelines, nor does it recommend, endorse or make any representations regarding the external reviewers listed".⁶ This is an issue in the crosshairs of the European Commission, which has advised that under the EU GBS, external verifiers of eligible bonds would be registered with and supervised by the European Securities and Markets Authority (ESMA), the operator of the external verification scheme.

⁴ Most prominently, ICMA. Other standard-setters include the People's Bank of China, the ASEAN Capital Markets Forum (co-ordinated with ICMA) and Japan's Ministry of the Environment.

⁵ International Capital Markets Association, External reviews, www.icmagroup.org/sustainable-finance/external-reviews (accessed 30 August 2021).

⁶ *Ibid.*

Reviewers then will be required to “meet the conditions for registration”, set out in Article 15(2), on an ongoing basis, as stipulated in Article 14 (European Commission, 2021).

Aside from the problems of the decentralized and unsupervised nature of external reviewers, conflicts of interest may arise. For example, a framework under review in an assessment may have been designed in partnership with the reviewer, posing challenges to objectivity and review independence, particularly under a *laissez-faire* labelling regime. Furthermore, most third-party review activity is conducted prior to or early in the life of an issuance, at a single point in time. Opinions are developed by assessing public documentation that is based on the intentions of the issuer, rather than observed realities. The current regime lacks mandatory, formal, continuous oversight. The issue of the perceived deficit in ongoing oversight is a free-rider problem that requires public sector intervention; external reviewers are not inherently incentivized to produce recurring opinions, to publicly disclose the results of ongoing assessments or to pool their experiential capital with other coordinators to improve assessment quality. It is also unclear how effective a coordinated standardized approach towards ongoing external assessment would be without developed enforcement infrastructure.

Fundamentally, the issue to address in the green bond market is one of uncertainty and asymmetric information about the quality of issuance, whereby both inherently green and inherently non-green issuers coexist in the market and whereby investors are susceptible to misallocating proceeds given the uncertainty about the inherent quality of the bonds observed in the market. Resolving this problem, by disproportionately disincentivizing participation by issuers of inherently non-green bonds, is critical to maximizing the positive impact potential of the market.

We can characterize the current market distinctly as an Akerlof (1970) setting, given the uncertainty about green bond quality, or greenness and the inherent asymmetry of information that exists among issuers and purchasers of green bonds. Recognizing the nature of the market, we can adapt the established academic corpus surrounding game theory, and in particular Bayesian games, to extrapolate policy-led solutions for the problems of the green bond market, encompassing the perceived deficit in the regulatory infrastructure. George Akerlof’s work regarding asymmetric information, which sets the foundation for our framework, contributed to his receipt of the 2001 Nobel Memorial Prize in Economic Sciences. Akerlof (1970, pp. 489–490) draws on an analogy from the automobile market to demonstrate that there is inherent uncertainty regarding the difference in quality of a car that a consumer may wish to purchase. A buyer in a showroom, as Akerlof (1970) frames it, may end up purchasing a good car, with probability q , or a “lemon”, an inherently bad car, with probability $1 - q$. Given the uncertainty of the buyer and the inaccuracy of their estimate of q at initial purchase, buyers’ most efficient strategy is to bid the conditional expectation given

what they observe – that is, the estimated probability of purchasing a good car or a lemon. When rational buyers play their most efficient strategy, they systematically overbid for lemons and underbid for good cars. This is the conception of the adverse selection problem and is the outline of a basic game, from which one can begin to model and resolve issues arising from Bayesian games.

3. Defining the adverse selection setting

This section introduces the basic “lemons problem”, the players in the game, their associated action spaces, their pay-offs and the prior probability of purchasing green debt or a lemon as observed in the market. This foundational adverse selection setting is the platform upon which our subsequent Bayesian games are built and assessed. The notation remains consistent throughout this paper.

Having established the basic adverse selection setting, the perfect Bayesian equilibrium (PBE), we then derive the most efficient bidding strategy for potential buyers and discuss the intuition. The implications of this Bayesian game concerning fixed-income instruments are compared and contrasted with those of games concerning equity instruments. The variations, arising because of differences in their respective pay-offs, are also discussed.

3.1. Notation

Within our Akerlof (1970) setting, we define issuers (denoted by M) issuing green debt and a pool of potential buyers (denoted by B). We assume that both sets of agents are rational, risk neutral and value-maximizing and that the universe of agents is sufficiently large and unconstrained by frictions to presume that the no-arbitrage condition prevails.

We denote the price paid in the primary market for the issued debt by P . The true worth of the issued debt, x , can take only one of two values, B , with probability p , or G , with probability $1 - p$, where $G > B$. True to the nature of asymmetric markets, we assume that the issuer always observes the true worth of their debt, whereas the pool of potential buyers only observe the prior distribution of the true worth of the debt, inferring the true worth (expected value) of the debt, x , which is equal to B with probability p and G with probability $1 - p$. Intuitively, prospective buyers cannot clearly distinguish between the quality of the bonds that they observe at purchase, but they know the probability and intrinsic value of purchasing debt G and B , respectively, which informs their optimal bidding strategy.

The pay-off to the issuer, π^M , can take either the form of the price obtained in the existence of a transaction or zero, in the event that a transaction does not occur. This is illustrated by:

$$\begin{cases} \pi^M = P \text{ if a transaction occurs} \\ \pi^M = 0 \text{ if a transaction does not occur} \end{cases}$$

By contrast, the pay-off to the pool of potential buyers, π^B , can take either the form of the true value of the debt minus the price paid, with the existence of a transaction, or zero, in the event that a transaction does not occur. This is illustrated by:

$$\begin{cases} \pi^B = x - P \text{ if a transaction occurs} \\ \pi^B = 0 \text{ if a transaction does not occur} \end{cases}$$

Here, we establish the pay-offs to the issuers and potential buyers. For an issuer of debt, success in issuing debt yields price P . When debt is not successfully placed, the pay-off to a debt issuer is zero, which contrasts with an issuer of equity that retains the intrinsic value of their equity ownership. For a potential buyer, the pay-off of a debt purchase is the difference between the price paid, P , and the intrinsic value of the debt, x . Naturally, in the case of no transaction occurring, the pay-off is strictly zero.

3.2. Decisions, responses and perfect Bayesian equilibria

The issuer's decision is limited to whether it should issue debt, S , or abstain from doing so, NS . Given the issuer's privately held information concerning the true worth of the debt, its response is contingent on potential buyers' bidding strategy relative to the true worth of the debt.

As potential buyers are not privy to the true worth of the debt, their collective bidding strategy, $P(X)$, is identical to and independent of the true worth of the debt.

In this scenario, only the following PBE can obtain:

$$[B : S, G : S; P(S) = E(x|S)]$$

Where $E(x|S)$ is the conditional expectation of the true worth, x , of the debt being issued, given the universe of debt for sale, S . This is effectively a weighted average of the true worth of the debt. As such, in this scenario $B < E(x|S) < G$.

Thus, issuers of both debt G and debt B are inclined to issue debt, even though the former recognizes a suboptimal bid, relative to the true value of its debt. This scenario contrasts starkly to the adverse selection setting in equity markets, where two PBE can obtain, where for firms of worth G , selling is off-equilibrium and not played in the strategy profile:

$$[B : S, G : NS; P(S) = B]$$

$$[B : NS, G : NS; P(S) = B]$$

where potential buyers of equity believe, using Bayes' rule (Bayes, 1763), that firms for sale are bad. When investors update their prior beliefs to reflect the optimal strategy of firms of worth G , their posterior beliefs indicate that only firms of worth G will be motivated to issue equity.

The fundamental difference driving the contrast in strategy profiles is the pay-off of a potential buyer of equity in a scenario where a transaction does not occur. Whereas the opportunity cost for a debt issuer of a transaction occurring is zero, an equity issuer retains the true worth of the firm, x , in the absence of a transaction. This provides equity issuers with embedded optionality not afforded to debt issuers and a strict incentive to deviate from selling their firms where $P(S) < G$. Similarly, but conversely, we then assume that a debt issuer is always inclined to issue debt (where $P(S) > 0$), given the pay-off in the event of a transaction not occurring. By extension, we assume that debt issuers are not indifferent about the source of capital raised. The difference in pay-offs can also be related to the pecking-order theory of capital structure (Myers and Majluf, 1984).

The result of the differences in the two capital issuers' pay-offs is that debt issuers are assumed to always be better off issuing debt than not, which is not the case for equity issuers, which observe a partial or total collapse in equity markets where equity issuers are not effectively forced to sell their firms and where the issuers are indifferent between abstaining from selling their firms and playing their equilibrium strategies. Throughout the following discussion, we assume that, where economic agents are indifferent between playing their equilibrium strategies and deviating, they will play their equilibrium strategy.

4. Free voluntary disclosure

Having defined a platform and notation for our game, we introduce a series of disclosure regimes and consider the resulting optimal strategies, inferring insights in pursuit of setting a design that facilitates perfect allocative efficiency. Such a conceptual setting that allows investors to distinguish between inherently green and non-green issuers, and by extension maintain confidence in the green bond market, depends on obtaining a separating equilibrium.

We begin by introducing basic free disclosure into our game. The free disclosure regime resembles the current regime for green bond labelling. We adapt the work of Crawford and Sobel (1982) to restrict the message space to green bond labelling, where the following relevant messages can be communicated by the issuer issuing debt: " G ", representative of "my debt is green" or " B ", representative of "my debt is non-green". The issuer may also elect not to disclose a message altogether (ND).

Practically, issuers can make disclosure " G " by integrating their intentions in their use-of-proceeds pledges in their prospectuses or final terms documentation.

Mirroring the current regime of voluntary processes, issuers' disclosures are not regulated; we assume no legal recourse or remedy in the case of greenwashing, where "G" is falsely claimed by issuers of debt that is inherently B. We infer from this that green labelling alone under this regime is not a credible market signal.

In this game construct only one PBE can obtain:

$$[B : "G", G : "G"; P(S) = E(x|S)]$$

Crucially, it not possible to obtain a separating equilibrium where the issuer of debt G is able to recognize the true worth of its debt. The issuer remains better off than not engaging in the transaction (pay-off zero) and hence does not have a strict incentive to deviate but recognizes a suboptimal value for the issuance. The issuer of debt B, unaffected by the factual inaccuracy of its disclosure, recognizes a value for the debt in excess of its true worth.

We reiterate here the proposition of Crawford and Sobel (1982), that voluntary disclosures cannot resolve adverse selection if they lack credibility, and herein lies a transferable inference for the green bond market. Across a broad continuum of debt, debt of true worth greater than x , where $E(x|S) < x \leq G$, is strictly disadvantaged as a result of capital misallocation. Buyers of inherently non-green bonds, under the expectation that they are green bonds, given the disclosure "G" that they observe, are incurring an unnecessary investment cost, $E(x|S) - B$, and an opportunity cost of potentially effecting greater positive impact through investing in an inherently green bond.

As with Akerlof's basic lemons problem, under this setting the market contains both green and inherently non-green debt and prospective buyers cannot effectively distinguish between the two types. As a result, the most efficient strategy constitutes bidding the conditional expectation of the market and thus over-rewarding inherently non-green issuers, by value $E(x|S) - B$, and under-rewarding inherently green issuers, by value $G - E(x|S)$. This incurs an opportunity cost of effecting marginal positive impact.

5. Truthful disclosure

Recalibrating our game to one of strictly truthful and relevant disclosures (Milgrom, 1981), we consider the best response of potential buyers of debt in resolving the adverse selection problem. Intuitively, truth resolves the problem of informational asymmetry between issuers and buyers of debt, a facilitative setting for a separating equilibrium to obtain.

In this setting we constrain issuers to sending messages that are reflective of the inherent value of their debt, such that issuers of truly green debt, G, are capable of

either disclosing “*G*” or withholding disclosure altogether (*ND*). Similarly, issuers of inherently non-green debt, *B*, are limited to disclosing “*B*” or withholding disclosure altogether (*ND*).

Given the setting, two separating PBE obtain:

$$[B : “B”, G : “G”; P(“B”) = B, P(“G”) = G]$$

$$[B : ND, G : “G”; P(ND) = B, P(“G”) = G]$$

Realistically, given Milgrom’s (1981) unravelling argument, an issuer that is strictly worse off by disclosing truthfully will refrain from disclosing altogether in a truthful disclosure regime. Cognizant of the disincentives of truthful disclosure of non-green debt issuers, potential buyers of debt will bid *B*. This reaffirms Ross (1979): agents with an incentive to obtain a separating equilibrium will be motivated to disclose voluntarily their private information.

Milgrom’s framework provides us with reassurance that a separating equilibrium can obtain and that there is a solution to the adverse selection problem in the Akerlof (1970) setting; however, the truthful regime that allows us to obtain this benign outcome is abstract: how can issuers be bound to only disclosing truthfully? Verrecchia’s (1983) developments provide us with a practical impetus and economic incentive for enforcing truthful disclosure among rational value-maximizing issuers.

6. Exogenously costly disclosure

Drawing on the truthful disclosure regime, we introduce the contributions of Verrecchia (1983) to allow issuers to disclose any relevant messages freely, but we impose a verification cost, *C*, upon the disclosure of messages. Verrecchia’s regime of costly disclosure is considered to be exogenous as the fee required to disclose is not explained by but rather produced outside of the economic model.

While the verification cost *C* is sufficiently low, such that $C \leq G - B$, issuers of inherently green debt have a strict incentive to voluntarily communicate “*G*” to the market. As long as the verification cost is greater than zero and the verification process is perfect, the best strategy of issuers issuing inherently non-green debt is to withhold disclosure altogether, *ND*. As such, a single separating PBE obtains:

$$[B : ND, G : “G”; P(ND) = B, P(“G”) = G]$$

If we were to restrict verification costs to only disclosures of “*G*” and “*B*”, one further separating equilibrium obtains:

$$[B : “B”, G : “G”; P(“B”) = B, P(“G”) = G]$$

While potential buyers cannot use Bayes' rule to form their posterior beliefs, disclosures are constrained to be truthful, and hence, it will be assumed that $P("B") = B$ and $P("G") = G$.

Given our assumptions within the game construct, we find that an exogenously costly disclosure regime can be a platform for resolving the adverse selection problem in the Akerlof (1970) setting; we demonstrate that a PBE does exist where verification costs are sufficiently low, the verification process is perfect and messages are thus credible. When considering practical applications of Bayesian equilibria to inform policy recommendations for the enforcement infrastructure that governs green bond issuance, we must consider further the limiting factors to the PBE that we have established. This model provides us with a framework that relies on economic incentives to influence the behaviours of rational value-maximizing issuers in order to improve the allocative efficiency of the market.

Exogenously costly disclosure. The green bond market should operate strictly under an exogenously costly disclosure regime.

In the case of the green bond market, there is currently no central regulator. The assumption of the European Commission as the de facto leader in developing an international gold standard would position the Commission ideally to propose the integration of its standard into the legislative and regulatory institutions of the European Union. The formal regulator would be in a position to define and levy the exogenous cost upon issuers wishing to adopt the labels aligned with the EU GBS. EU institutions such as the Committee of European Auditing Oversight Bodies have an established track record in consulting with a broad base of financial institutions as well as in issuing and overseeing directives and regulations to optimize the process of issuer reporting and statutory auditing.

As a further assessment of the model to explore the practicalities, having identified the constraints to verification costs that render a separating PBE viable ($0 < C \leq G - B$), we now consider the realistic expectation that the verification process is imperfect. Specifically, we define the accuracy of the green audit, correcting for expected failures, as quality, q , and investigate the importance of disclosure credibility.

We recall Verrecchia's costly exogenous disclosure setting, allowing issuers to send the message " B " (representative of "my debt is non-green") or withhold disclosure altogether, ND , costlessly, but impose a verification cost, C , upon messages of type " G " (representative of "my debt is green"). As a result of the verification process, issuers declaring " G " receive a public green audit report detailing either a confirmation, g , that the alleged green bond is indeed green, or b , signalling to the market that the claim " G " by the issuer is a falsehood. We assume that green audit reports of inherently green issuers always yield report g , but impose a quality restriction, q , on the audit of inherently non-green issuers claiming to be green, " G ".

This represents “slippage”, or the positive expectation that an inherently non-green issuer is able to falsely claim that its debt is green and have this disclosure be credibly reaffirmed, g , with probability $1 - q$:

$$\begin{cases} p(g|G) = 1 \\ p(b|B) = q \text{ with } 0 < q < 1 \end{cases}$$

We assume that a green auditor operates under the principle of *ei incumbit probatio, qui dicit, non qui negat*,⁷ whereby a bond disclosed as green is assumed to be so, unless a discrepancy is found. In the case of the inherently green issuer, no such discrepancy exists, but the quality constraint when auditing inherently non-green debt represents the chance of a discrepancy not being identified.

In this setting, two PBE obtain:

$$\begin{aligned} [B : ND, G : "G"; P(ND) = B, P("G", A, g) = g] \\ [B : "B", G : "G"; P(ND) = B, P("G", A, g) = g] \end{aligned}$$

Mandatory green audit. The green audit process should be standardized (universal) and integrated into the legal enforcement infrastructure. A high quality of audit must also be upheld.

The proposals of the EU GBS outline the intention to have ESMA formally oversee and verify external verification processes, which would be mandated. In addition, the EU GBS proposes standardized minimum reporting. Use-of-proceeds pledges will also be required in legal documentation, but no clear enforcement function has been identified in the proposals and the issue of liability equivocation has not been explicitly addressed. Furthermore, it is unclear how extensive the audit process will be; the reporting reconciliation process and the alignment assessment of impact measurement methods, such as carbon accounting, remain undefined. Prescribing a thorough audit regime is critical to upholding audit quality.

The PBE are constrained by conditions concerning the cost and quality of verification, which must be satisfied:

$$(1 - q)(G - B) \leq F \leq G - B$$

From this we can infer that the separating strategy profile is in equilibrium while the audit fee is sufficiently high and, simultaneously, sufficiently low such that rational

⁷ A legal maxim, expressing the presumption of innocence: “Proof lies on him [sic] who asserts, not on him who denies”.

issuers issuing inherently non-green debt are disincentivized from sending the audited message “G” (or strictly disincentivized from deviating and pooling with the managers of the inherently green debt), and rational issuers of the inherently green debt are strictly incentivized to send the audited message “G”.

Fee optimization. The cost of label verification should be sufficiently low to prevent disincentives for issuers of inherently green bonds, but sufficiently high to prevent issuers of inherently non-green bonds from green labelling (although this is simultaneously dependent on the quality level of the green audit).

Asymmetric deterrence supplementing fee optimization. A secondary class of cost should be introduced to penalize greenwashers. There should be a penalty and clearer course of legal recourse to disproportionately deter issuers of inherently non-green debt from (mis)labelling their bonds as green. This requires the public provision of a centralized supranational label oversight infrastructure and enforcement mechanism, operating to review labelled issuances throughout a continuous cycle.

Centralized enforcement supplementing asymmetric deterrence. Effective continuous oversight must be accompanied by the mandating of minimum disclosures, referencing a designated reporting template and a publication schedule.

When we consider the practical applications of these inferences, we must consider that the true worth or greenness of issuance may be subject to change, absent of any changes in the broader market. As such, the audit process must be considered as a continuous process that tracks the allocation of capital against the proposed use of proceeds to monitor possible greenwashing. Furthermore, when we consider the audit cost, C , the level of flexibility of altering costs to disincentivize inherently non-green issuers of debt from sending the message “G” is constrained by the imperfect quality of audit and the equal and opposite impact on incentivizing issuers of inherently green issuers from sending the message “G”. There is, however, an additional class of costs that can be levied on market participants which affects issuers of inherently bad debt disproportionately; penalties for greenwashing and clear paths for legal recourse, inter alia, can be considered for disincentivizing the participation of inherent non-green issuers in the green bond market. The expected financial and reputational cost for an inherently non-green issuer is substantially higher than that of an inherently green issuer when issuing the message “G”.

7. Discussion and policy implications

In this section, we reflect on the incumbent labelling regime, deriving insights from our Bayesian games, and recommend corrective policy measures for policymakers and regulators, drawing more widely upon the mechanics of reporting and enforcement mechanisms from financial market literature. The recommendations outlined are compared and contrasted with the proposed EU GBS regulation, drawing further upon our Bayesian games. Finally, the expected implications of the enactment of the proposed recommendations and, separately, the enactment of the proposed EU GBS regulation by the European Commission are discussed.

7.1. The vulnerabilities of the current labelling regime for green bonds

Borrowing the frameworks developed and refined by Jung and Kwon (1988), Milgrom (1981), Myers and Majluf (1984), Sobel (1982) and Verrecchia (1983), we illustrate that a free (voluntary) disclosure regime, mirroring the one that the green bond market currently operates under, can only obtain suboptimal capital allocation solutions in the PBE in the Akerlof (1970) setting. The economic incentives inherent in the current regime leave the market susceptible to greenwashing as issuers of inherently non-green bonds pool with issuers of inherently green bonds, sending a virtually identical signal to the market; when both inherently non-green and green bonds issuers send a similar signal, the ability to distinguish between the green quality of the issuances becomes inconsistent and unreliable. As such, investors bid the conditional expectation given what they observe across the market. This results in adverse selection, as investors invariably purchase inherently non-green bonds and contribute to the systematic over- or underpricing of inherently non-green or green bonds. This adverse selection issue persists as limitations exist on issuers of inherently green debt from credibly distinguishing themselves and obtaining a separating equilibrium; issuers of non-green debt are strictly disincentivized from deviating and, instead, pooling (albeit unfaithfully, considering their private information of the true greenness of their debt, if we assume that the issuers themselves are cognizant of whether or not their type of debt is inherently green).

7.2. Addressing the vulnerabilities of the current labelling regime for green bonds: recommendations for policymakers and regulators

Despite the current constraints on obtaining a separating equilibrium, we find that a separating equilibrium can obtain under an exogenously costly disclosure regime, given a set of conditions regarding the quality and cost of credible verifications.

Based on the inferences, we can propose the following policy recommendations developed earlier:

Exogenously costly disclosure. *The green bond market should operate strictly under an exogenously costly disclosure regime.*

In practice, this requires an external cost to be levied on all adopters of the green bond label; *mandatory green audit* provides us with an impetus for this and *fee optimization* provides a theoretical framework for defining costs.

Mandatory green audit. *The green audit process should be standardized (universal) and integrated into the legal enforcement infrastructure. A high quality of audit must also be upheld.*

The auditor, in practice, is the green bond external verifier (this language is used interchangeably with second-party opinion providers). Currently, these entities are unsupervised and no enforcement mechanism exists. The infrastructure is devoid of a regulatory or monitoring body, which are required to uphold enforcement and, by extension, label credibility. Drawing parallels from financial markets, the regulator is typically a government or supranational agency. There is currently no clear ownership of green bond regulation at the sovereign or the supranational level. Although the EU GBS is not proposed to supersede the ICMA principles and guidelines by the TEG, it hypothetically offers an alternative route for participants to engage in the market, with a greater degree of supervision. *Asymmetric deterrence* and *centralized enforcement* provide a conceptual elaboration on the enforcement process.

Fee optimization. *The cost of label verification should be sufficiently low to prevent disincentives for issuers of inherently green bonds, but sufficiently high to prevent issuers of inherently non-green bonds from green labelling (although this is simultaneously dependent on the quality level of the green audit).*

Building upon *exogenously costly disclosure*, the label verification cost can be the impetus for imposing a cost on label adopters. This should be operated under the purview of the regulating bond, which as of yet has not been established. The cost, however, must satisfy the delicate compound inequality established in section 6, such that there remains an economic incentive for issuers of inherently green debt and a strict disincentive for those of inherently non-green debt, adjusting for the slippage that arises from deficiencies in the quality of the green audit. This presents a contingency: the labelling fee should be within the bounds of the pricing premium, such that there is a net benefit for issuers. A further question arises about the isolation of the observed premium. For an issuer engaging for the first time in the market, in addition to the greenium, their non-green debt curve may also be a beneficiary of the halo effect.⁸ A challenge for a regulator in establishing

⁸ See, inter alia, Krebbers (2019).

fees will be setting them to satisfy the compound inequality, which relies on the observed pricing premium of an inherently green, green-labelled bond relative to a non-green bond, which is not a stationary concept.⁹ Furthermore, regulators would have to establish a fee model that is either flat across all issuances or variable – for example, depending on the size of the issuance (or the issuer), the complexity of assessment required or the time to maturity of the bond at issuance. These factors and the design of the fees may be a source of additional economic incentives or disincentives that could motivate a change in the structure of the market, shaping the frequency, size and duration risk exposure of issuances in the aggregate.

Asymmetric deterrence supplementing fee optimization. *A secondary class of cost should be introduced to penalize greenwashers. There should be a penalty and clearer course of legal recourse to disproportionately deter issuers of inherently non-green debt from mislabelling their bonds as green. This requires the public provision of a centralized supranational label oversight infrastructure and an enforcement mechanism, operating to review labelled issuances throughout a continuous cycle.*

Once a regulator is established, a mandate based on the principles of the standard-setters should be enacted into supranational or jurisdictional laws, through regulations or directives to empower the regulator with the legal apparatus to initiate disciplinary proceedings against issuers of inherently non-green bonds that mislabel their bonds as green, and to send a credible enforcement signal to the market.

Centralized enforcement supplementing asymmetric deterrence. *Effective continuous oversight must be accompanied by the mandating of minimum disclosures, referencing a designated reporting template and a publication schedule.*

Oversight by the regulator and the associated infrastructure would require periodical disclosures, similar to the minimum disclosure and frequency requirements and associated penalties of standard financial reporting.

7.3. Policy implications in the context of the EU GBS

The Technical Expert Group (TEG), set up by the European Commission, was presented with formal actions under the Commission's Action Plan on Financing Sustainable Growth aligned with the Commission's legislative proposals that included (Action 2) assisting in the formulation of an EU GBS, an envisioned gold standard for issuers seeking to participate in the green bond market.

⁹ Could the balance of the perceived market green bond premium, which may oscillate over time, and a stable fee regime alter the natural pattern of issuance and influence swings in greening behaviour throughout the economic cycle?

The TEG (2019) explicitly identifies several of the perceived barriers preventing the development of the green bond market. The following paragraphs relate the EU GBS proposals to the recommendations formed from the Bayesian game theory insights explored in this paper.

Exogenously costly disclosure and fee optimization

In contrast to the recommendations derived from our Bayesian games, the EU GBS proposals aim to reduce the “complexity and costliness” of reporting and external verification through the standardization and streamlining of verification processes, as outlined explicitly by the TEG (2020, p. 12). In isolation, this may seem like an antithetical precedent that enhances the economic incentive for issuers of inherently non-green debt to pool with issuers of inherently green debt in engaging in green labelling, if the fee reduction causes the cost of the fees to be exceeded by a function of the pricing premium of the inherently green bond to a non-green comparator and the audit slippage. The fee structure has yet to be finalized, but the purported reduction in complexity and costliness may not apply to low-touch issuers, which, for example, may have not commissioned an external review or verification (which under the EU GBS becomes a requirement) or invested substantially in designing a framework and proceeds-management processes. Inherently low-touch issuers will likely be dissuaded altogether from engaging in EU GBS label adoption because of the higher, broad-based obstacles introduced in the proposed regulation. As such, the reduction in “complexity and costliness” in the context of the body of the TEG’s proposals may be viewed as a disproportionate economic incentive for issuers of inherently green bonds, in line with the precedent established from our Bayesian games. We can derive the extent of the incentive or disincentive conceptually by considering the reduction cost of green labelling (F) relative to the observed premium of an inherently green bond relative to a non-green comparator and the observed quality of audit, in the compound inequality established in section 6. Policymakers should be cognizant of proposals that introduce disproportionate incentives or disincentives to different groups of issuers as these may result in a bifurcation in the inherent cost of green labelling for each group. This would require us to consider the effective cost of green labelling and the satisfaction of the underlying constraints for each group separately. Policies that motivate greater signal differentiation and support the obtainment of a separating equilibrium are desirable in the pursuit of perfect market efficiency.

Mandatory green audit

In pursuit of reassuring issuers concerned about “reputational risks and [the lack of clarity of] green definitions” (TEG, 2020, p. 12), the EU GBS “builds on the EU Taxonomy to clarify green definitions” and “foresees a robust registration scheme for external verifiers and a clarification of their role and responsibilities to verify EU

Taxonomy alignment.... Furthermore, reporting is expanded and standardised, requiring issuers to report on impact as well as clarify up front their impact reporting methodology”.

The language and intentions expressed by the EU GBS align with the spirit of a *mandatory green audit*; that is, the quality of the green audit, q , should be upheld to minimize the leakage (or slippage) of inherently non-green bonds into the market and, by extension, the inherent economic incentive for issuers of non-green bonds to mislabel their debt. The extent of the increased economic disincentive can be derived by considering the increase in q , in relation to the observed premium and the cost of issuance, from the compound inequality established in section 6.

A critical point is that the proposals ensure that the external verifier accreditation scheme will be centralized and operated by ESMA, which is presumably supportive of the consistency and the quality of verification. There will be a voluntary interim registration scheme for an estimated transition period of up to three years (TEG, 2019, p. 13).

Asymmetric deterrence and centralized enforcement

Whereas the ICMA Green Bond Principles currently only recommend that use-of-proceeds pledges be integrated in legal documentation, external reviews be conducted and that external verification be published, the EU GBS proposals mandate these features (TEG, 2019, p. 13). This mandate fundamentally introduces an exogenously costly setting and one that resembles Verrecchia’s setting, consisting of audited messages. The greater degree of transparency and accountability should reduce informational asymmetry and support in mitigating adverse selection. Despite this, however, there is no clear deterrent or penalty for greenwashing;¹⁰ clear regulations (or directives) regarding misaligned behaviour and corresponding repercussions have not been established. The proposed mandated reporting is indeed standardized, offering impact monitoring based on disclosures of estimated and/or actual impact. Issuer reporting is expected to occur at least annually until the full allocation of the reference green bond, which aligns with the recommendation for ongoing mandated minimum disclosures, referencing a designated reporting template. However, post-issuance reporting is not proposed to undergo mandatory continuous review, only initial external verification.

¹⁰ Although the integration of use of proceeds into legal documentation has been mandated, the prospectus language that often accompanies these pledges is frequently designed to limit issuer liability in the event that the deployment of (green) funds does not align with the intended use of proceeds. The potential flexibility of issuers to equivocate beyond liability brings into question the credibility of legal recourse and the robustness of green bond labelling. There is, however, anecdotal evidence that markets internalize this information, such as in the case of the “greenfault” of the Mexico City Airport Trust.

The integration of ESMA as the formal operator of the external verification accreditation scheme offers the expectation of greater centralization in the verification process, but there is no clear direct supervision. Although it is out of the scope of the Bayesian game theory framework, which is conceptual and preserves generality, policymakers should look closely at the effectiveness of oversight and the perceived deficit in the market's enforcement mechanisms. Article 47 of the European Commission (2021) identifies persons and entities under ESMA's proposed supervision, all strictly external verifiers and/or affiliates, which are directly supervised and in the event of non-compliance and/or infringements of Article 47(1) may incur fines ranging from EUR 20,000 to EUR 200,000, as set out in Article 52 (European Commission, 2021). Although this sends an enforcement signal, this structure forms a supervisory cascade, in which external verifiers form a metaphorical buffer, preventing penalties from being levied on issuers, dissolving the potency of the deterrent against inherently non-green issuers wishing to participate in the economic benefits of the market. The direct supervision and enforcement of minimum requirements should be considered for issuers in order to asymmetrically disincentivize inherently non-green issuers. The perceived sympathetic approach of the proposal to issuers implies some level of uncertainty among issuers of their private informational endowments on the inherent greenness of their bonds, shifting the liability and the onus onto external verifiers, which are tasked with determining a bond's fitness for labelling. The proposal (European Commission, 2021, p. 2) reads: "For issuers, the lack of common definitions of environmentally sustainable economic activities creates uncertainty about which economic activities can be considered to be legitimately green".

The credibility of the enforcement signal is of utmost importance. To draw parallels with financial auditing and accounting standards, academics find that among the factors influencing firms' incentives are differences in investor protection and enforcement systems (Leuz, 2010; Christensen et al., 2013). To improve audit quality and decrease the economic incentive for inherently non-green issuers wishing to opportunistically mislabel their debt as green, the label standards must be accompanied by a strong institutional setting and effective enforcement. Enforcement is critical to shaping incentives and disincentives, which owners and managers respond to by reforming their practices. Further parallels that emphasize the dangers of misaligned incentives and the criticality of a credible enforcement mechanism can be drawn from Ball et al. (2003), Burgstahler et al. (2006), Daske et al. (2008) and Leuz et al. (2003).

7.4. The implications of the recommendations on market dynamics

One would expect the recommendations, when implemented, to support confidence in and the credibility of the green bond market and to improve the allocation of capital, optimizing the efficacy of green bonds as transmission

vehicles of development capital. *Ceteris paribus*, one would expect the premium of inherently green bonds relative to non-green bonds to increase as a result of the increased confidence and improved capital allocation decisions of potential buyers.¹¹ This increase would be expected to serve as a tailwind to support further penetration of the green bond label and the efficacy of each incremental unit of investment in driving environmental and social impact, spurring a virtuous cycle of balanced economic transitioning. The TEG (2020, p. 12) similarly identifies “[a]bsence of clear economic benefits for issuers” as a barrier to market development and posits that “[s]tandardization and a proposed endorsement by the EC... lay the basis for policymakers to design policies and instruments to incentivise green bond issuance”.

These recommendations are timely, following sovereign and supranational impetus to “build back better” in a post-pandemic world and commit to large-scale green infrastructure programmes, alongside the adoption by central banks of sustainability-conscious targets within their mandates. Formal solicitations by the European Central Bank and the Bank of England regarding the greening of their corporate bond purchasing activity alongside the material growth in the impact finance market demonstrate that green bonds are likely to be a pragmatic mechanism to support the rebuilding and transitioning of post-pandemic economic activity. Reinforcing and regulating the current regime for green bond labelling will be vital to ensuring a highly credible, efficient and effective market, primed for the scale of activity that is required by private and public institutions to satisfy the needs of the ambitious transition.

7.5. The implications of the EU GBS for corporate issuers

Issuers of inherently green debt should welcome the arrival of the EU GBS. As an additional voluntary label, the EU GBS builds upon the ICMA principles and guidelines that market participants have come to understand and engage with materially, introducing additional layers of supervision and minimum requirements. These additional compulsory direct and indirect costs should disincentivize inherently non-green issuers from mislabelling their bonds more than proportionally and allow the market to better resemble Verrecchia’s exogenously costly setting with message (label) auditing. This makes it more feasible that a separating equilibrium will obtain and that inherently green issuers will be able to better distinguish themselves through their market signals from inherently non-green issuers.

¹¹ The greenium, while being an opportunity cost for an investor, represents the economic incentive for an issuer that engages in debt greening as it represents the prospect of a lower cost of capital. A higher greenium increases the economic incentive for incumbent (and prospective) issuers to (further) issue green bonds.

In principle, provided that the compound inequality established in section 6 is satisfied, the adverse selection problem should be alleviated and the market should be more efficient in allocating capital. This, in turn, implies that the bidding strategies of investors should tend towards the true worth of inherently green debt and away from their optimal strategy in the incumbent setting, bidding the conditional expectation given what they observe in the market; said differently, investors' systematic under-pricing of inherently green bonds should tend towards fair pricing and subsequently increase the pricing premium of EU GBS-aligned bonds relative to the broader green bond market, supporting lower capital costs and increasing issuer value. A higher observed pricing premium should further increase the incentive for and viability of broader participation by inherently green issuers.

Furthermore, it would not be unreasonable to expect the EU GBS, given the presence of supervision and mandated minimum requirements, to become a precedent for engagement by some institutions, for example, as a basis for the greening of central banks' corporate asset purchase programmes.¹² If such engagements occur, this could result in aligned bonds benefiting from a greater degree of price support. Issuers benchmarking their green issuances to the EU GBS create opportunities to send a credible market signal and benefit from any resultant premia as investors tighten their investment standards and seek out allocatively efficient markets for deploying sustainable development capital optimally.

Despite the improved market efficiency, however, higher barriers to entry may disincentivize issuers on the margins,¹³ scaffolding a bifurcation of capital and entrenching structurally disadvantaged issuers that are sorely in need of transition capital. There is a delicate balance of trade-offs when developing sustainable policy; to strive towards a perfectly efficient labelling regime risks creating a bottleneck in issuance. A challenge will be to balance perfect efficiency and perfect inclusivity. Policies must asymmetrically disincentivize greenwashers but should not be so onerous as to restrict structurally disadvantaged issuers that wish to make some sustainable commitment from participating. Is it more desirable to have imperfectly efficient markets

¹² The European Central Bank recognizes that "Issuing EuGBs [...] could lead to better insights into the importance of environmental objectives [...] improving the ability of all financial actors, including the ECB, to reliably identify and evaluate environmentally sustainable bonds" (European Central Bank, 2021, p. 3). Nevertheless, the ECB raises issues and proposes amendments to the EU GBS regulation as proposed (European Central Bank, 2021, p. 16–22).

¹³ These are the in-between issuers on the green/non-green continuum, which are considered to issue debt for "light green" projects. They are not greenwashers, but they are committed to projects with lower "green ambition" relative to inherently green projects.

and some sustainable commitment through “light green” activities,¹⁴ or to have perfectly efficient markets with no commitment at all from otherwise light green issuers?

8. Summary conclusions

As the green bond market becomes systemically engrained as a means for internalizing externalities, re-adjusting risk perceptions (G20, 2016, p. 3) and aligning economies with the Paris Agreement (UNFCCC, 2015), its incremental growth and potential to effect positive change are constrained by the prevailing labelling regime’s susceptibility to greenwashing. Greenwashing risks eroding confidence in the segment and reducing its potential to effect positive impact through perpetuating the inefficient allocation of capital.

On the basis of Bayesian game theory and research from the broader financial market literature, this paper explores how the incumbent green bond labelling regime should be reformed in pursuit of obtaining perfect allocative efficiency and upholding market confidence.

It recommends that the green bond market should operate strictly under an exogenously costly disclosure regime, providing a conceptual framework for defining the associated costs, where a standardized “green audit” is mandated and integrated into the legal enforcement infrastructure. This paper proposes the introduction of a designated reporting template and a periodical publication schedule, which should be subject to centralized, ongoing oversight and supplemented by a secondary class of credible enforcement costs to penalize greenwashers and asymmetrically deter their participation in the market.

¹⁴ This is a simplification. There is a discussion to be had about whether reducing standards for issuers on the margins so that they can participate to a greater degree reduces ambition across all segments. Do inherently green issuers, for example, uphold the same degree of greenness in the aggregate across all labelling regimes?

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