

Sustainable Finance

**WHAT DOES ECONOMIC
RESEARCH SAY?**

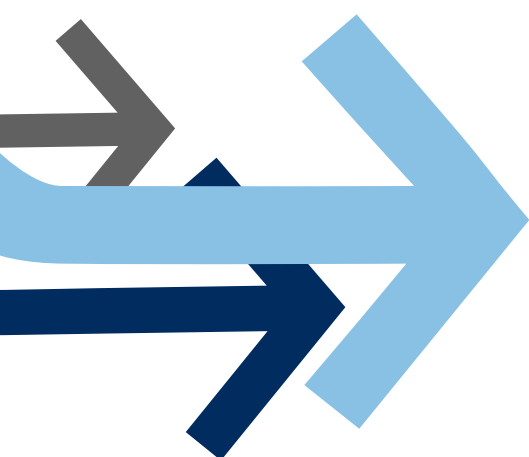


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Sustainable Finance



What Does Economic
Research Say?



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This study presents, from the perspective of different financial market actors, a brief state of play of the main issues addressed by the academic economic literature (both theoretical and empirical) following the inclusion of sustainability in Finance.

From the investor perspective, empirical work addresses sustainability by researching, for example, whether there are significant differences between investors' returns on sustainable versus traditional financial products, while in theoretical work, sustainability is implying a revision of traditional models of portfolio selection and asset pricing.

Regarding those that focus on the issuers' perspective, the literature is focused to a large extent on how sustainability may affect the cost and the amount of financial resources they raise in the markets and how companies can attract this finance by signalling the market in different ways about their quality as sustainable. The role of regulators then emerges, who have

to define the criteria that make the company's commitment credible, and the debate arises between self-regulation and public regulation of sustainable financial product markets.

This paper also takes into account the perspective of supervisors, in this case of the financial system, analysing the active role that central banks may play in support of a sustainable economy. The study points out how the incorporation of sustainability highlights the existence of previously unconsidered risk factors, such as the carbon premium of securities with higher emissions or, conversely, the possible lower financial risk of sustainable banks. It also notes several studies showing how climate risks are already reflected in asset prices, such as the higher returns required for municipal bonds of localities more exposed to flood risks. This study, in short, takes the pulse of an intense academic activity related to sustainable finance and its impact on the financial industry and the corporate sector, which is currently in expansion.

1. Sustainable Finance: Origin and Mission

Sustainable finance is part of a broad and ambitious undertaking: sustainable development. The idea of sustainable development appeared in the late 1950s and later in the 1960s in various relevant official documents⁽¹⁾, but it was defined, as it is understood at present, in 1987 in the Report of the World Commission on Environment and Development, chaired by Dr Brundtland and therefore also known as the Brundtland Report. It states that it is “development that meets the needs of the present without compromising the ability of future generations to meet their own needs”. The growing concern for the sustainability of development was enhanced in 2015 by two historic events. On the one hand, the UN General Assembly approved a global program, the 2030 Agenda for Sustainable Development, with 17 goals and 169 targets covering the three dimensions of sustainability: environmental, social and corporate governance (ESG criteria)⁽²⁾. On the other hand, an agreement was reached to combat climate change — the Paris Agreement — which is legally binding for the 189 countries that have ratified it so far, although 197 countries have adopted it⁽³⁾.

To these two milestones for sustainability we must add the progressive awareness among citizens, whose ability to access information on the serious consequences of environmental disasters, the non-compliance of basic human rights in the activities of some companies or the corrupt practices that have triggered serious world crises is becoming increasingly rapid and global. This has led to a clear cultural shift, particularly since the end of 2015, which demands an increasing degree of sustainability in the economic growth model.

Thus, once the step has been taken to define in a comprehensive manner the final objectives that sustainable development should have, it was necessary to establish how this process should be financed. This is when the concept of sustainable finance, linked to that of sustainable development, emerged. Although, as the Spanish National Securities Market Commission (CNMV) points out, there is no definition of sustainable finance that is commonly accepted in the international environment, the European Commission considers sustainable finance

1 This is the case of the National Environmental Policy Act of 1969, in which the US government guarantees in a law that all public authorities must take the environment into account before undertaking any major federal action that significantly affects it. Previously, in 1957, the Treaty on European Union, in its Article 2, had included this idea less explicitly as one of its founding principles: “The Community shall have as its task to promote (...) the harmonious development of economic activities”. In the Maastricht Treaty of 1992, this article was extended to explicitly include environmental protection: “(...) a harmonious and balanced development of economic activities throughout the Community, sustainable and non-inflationary growth respecting the environment (...)”.

2 The acronym ESG came into use in 2004 in the “Who Cares Wins” report (https://www.ifc.org/wps/wcm/connect/topics_ext_content/ifc_external_corporate_site/sustainability-at-ifc/publications/publications_report_whocareswins_wci_1319579355342).

3 Previously, various events had been paving the way for this qualitative leap observed in 2015. As regards the environment (criterion E of the ESG criteria), in 1972 the United Nations created an agency (The UN Environment Program) to promote environmental policies in developed countries. Also in that year, the United Nations Conference on the Human Environment was held in Stockholm. As a result of the aforementioned Brundtland Report, in 1992 the UN organised the Earth Summit in Rio de Janeiro, attended by 172 countries in an attempt to promote sustainable development. Five years later, in 1997, the Kyoto Protocol was adopted, an international agreement that already set concrete targets for reducing greenhouse gas emissions. Regarding corporate governance (i.e. criterion G), a historical vision of the development of Corporate Social Responsibility (CSR) can be found in Carroll (2008, 2021), and in Pollman (2022) of the ESG criteria and their interrelation with sustainability and CSR. Chronologically, the term CSR is the oldest (Bowen, 1953) and the most recent is ESG, as mentioned above. As Pollman points out, while the environmental criterion (E) began to gain strength among investors and issuers after the Brundtland Report cited above, the criterion related to corporate governance (G) was already, to a large extent, incorporated by financial market actors, albeit from an initially abstract perspective of business ethics, which subsequently became more specific with the publication of the Codes of Good Governance. Thus, the Cadbury Code in 1992 expressed the need to improve corporate governance control mechanisms, especially with regard to the financial information provided by British corporations and accountability, and it did so through self-regulation, with a series of recommendations. Since then, this type of codes has been extended to other economies (Viènot Reports in France (1995), Olivencia Code in Spain (1998), Italian Code of Good Governance (1999), German Code of Corporate Governance (2001), etc.) and their publication is becoming mandatory. At present, and since 1992, there are around 500 good governance codes, principles and recommendations worldwide, according to data from the European Corporate Governance Institute (ECGI). Another notable development in this area was the enactment of the Sarbanes-Oxley Act of 2002, as it was already a legislative response to the corporate scandals that had wide impact in the USA at the beginning of the 21st century. Finally, it could be highlighted the Davos Forum of 1999, as it represents a leap from national to international measures, calling on multinationals to self-regulate in order to respect basic rights in the countries where they carry out their productive activity. In short, the current continued and steady progress towards sustainability is the result of a process that began decades ago with certain discontinuities. Perhaps the current post-pandemic and energy crisis situation implies another discontinuity in this trend.

to be finance that supports economic growth while reducing pressures on the environment and taking into account social and corporate governance aspects. The CNMV recognises three types of sustainable financial products in its guide⁽⁴⁾:

- (i) green and social bonds;
- (ii) investment funds that apply ESG criteria; and
- (iii) solidarity investment funds⁽⁵⁾.

Green and social bonds are fixed-income securities that finance projects with environmental objectives or social activities. Investment funds that apply ESG criteria include consideration of such criteria in their investment policy, while solidarity investment funds assign part of the fund management fees to charitable or non-governmental organisations.

Sustainable finance also encompasses transparency regarding risks related to ESG factors that may impact the financial system, and the mitigation of those risks

through appropriate governance of financial and business actors⁽⁶⁾. Therefore, the consideration of climate risk, which includes both physical risk (associated with the effects of weather events caused by climate change) and transition risk (linked to the economic effects of the shift to a decarbonised economy), are essential aspects of sustainable finance due to their potential impact on financial stability.

Thus, the “mission” of finance with respect to sustainability is to facilitate the flow of financial resources towards those activities or companies that make development sustainable and involves not only investors, but also issuers and their governance, financial market regulators and supervisors of credit institutions.

In the following sections we discuss, without the intention of being exhaustive, some of the main issues that the academic literature (theoretical and empirical) addresses regarding the effect that sustainability has, from a financial perspective, on these players in the financial system.

2. Sustainable Finance: The Investors

The development of sustainable finance raises a number of academically relevant questions for investors: What drives investors to choose sustainable financial products instead of traditional ones? Are they more profitable? Less risky? Do they allow for a better portfolio diversification? All these questions can be summed up in just one: Is the theoretical framework of reference usually used in the analysis of investors’ portfolio choice still valid?⁽⁷⁾

In the academic field, we explain the behaviour of investors in terms of their financial decisions using the Markowitz portfolio selection model⁽⁸⁾. The first thing Markowitz teaches us is that investors select assets portfolios, not

individual assets, that is, they choose between different combinations of available assets, between different portfolios. To make their selection, they take into account two elements: on the one hand, the set of efficient portfolios (i.e. the portfolios with the minimum risk for a given return, or with the maximum return for a given level of risk) that can be formed with the available set of assets, i.e. the so-called efficient portfolio frontier and, on the other hand, the investors’ preferences, expressed in terms of the portfolio return and risk (measured by the mathematical expectation and the variance, or the standard deviation, of the portfolio rate of return)⁽⁹⁾.

4 See CNMV, Finanzas Sostenibles [Sustainable Finance]. Quick guide: <https://www.cnmv.es/portal/Publicaciones/Fichas.aspx>

5 Other noteworthy financial products are microcredits whose origin predates the consolidation of the concept of sustainable finance. In addition, other sustainable products such as blue bonds, transition bonds, etc. can be found on the financial markets.

6 See https://ec.europa.eu/info/business-economy-euro/banking-and-finance/sustainable-finance/overview-sustainable-finance_en#what

7 The so-called Ecological Finance Theory even proposes the need for a new paradigm in Finance based on methodological principles that are clearly different from those of traditional theory (see Lagoarde-Segot and Martínez, 2021). We would like to point out that the academic contributions reviewed in this section essentially fall within the framework of conventional Finance Theory, which remains the dominant paradigm today.

8 See Markowitz (1952).

9 Since we do not know with certainty how the portfolio performance will evolve, we are actually choosing between probable, not certain, future outcomes. Actually,

The relevant question is whether this framework of analysis is still valid for studying investor decisions in the presence of the new sustainable financial assets arise. If such products generated more favourable risk-return combinations or if they made a significant contribution to improving the diversification of agents' portfolios, their inclusion in portfolios would not be a surprise and would

not represent anything new in relation to the traditional theoretical framework. However, if this were not the case, it might be possible that investors were taking into account factors that were not incorporated in the traditional analysis and which would be important to take into consideration. Let us see what the academic literature has to say in this regard.

Return differences between green and brown assets

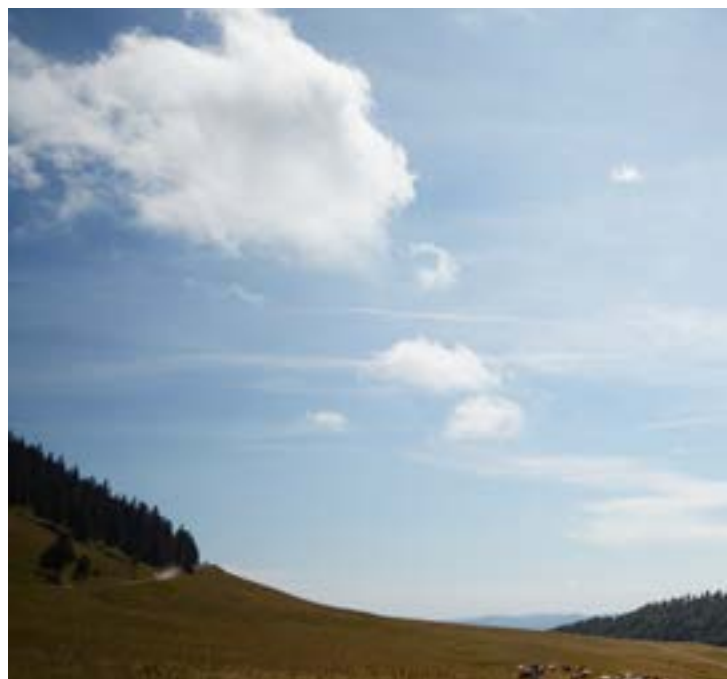
Although, as we have previously pointed out, there are various financial products related to sustainable finance, most of the existing studies have focused on the so-called green bonds, given the notable increase in their issuance, particularly since 2015 with the signing of the Paris Agreement⁽¹⁰⁾. Thus, various studies have analysed whether these bonds have higher returns than similar conventional bonds and this is the reason why they are being included them into the investors' portfolios. The results in this respect are inconclusive, since while some papers find that the rates of return of these bonds are higher than those of conventional ones, others find no significant differences, and some show evidence of lower returns⁽¹¹⁾.

Among the first ones, the work of Bachelet et al. (2019) raises the existence of a puzzle in relation to green bonds, as they find that, in addition to show higher returns than their

conventional equivalents (brown bonds), they present lower volatility and greater liquidity, although this all depends on the issuers and whether the bonds are verified by an external agency⁽¹²⁾. In turn, Flammer (2021) concludes that there are no significant differences between green bonds and their equivalent brown bonds in terms of rates of return, and that they would therefore not be particularly interesting for investors. On the other hand, Gianfrate and Peri (2019) find for their sample that the returns of green bonds are lower than that of conventional equivalents, raising the need to find out additional reasons to better understand why they are included in the investors' portfolios. Recent work by MacAskill et al. (2021) systematises previous works concluding that the returns on green bonds in the secondary market are lower than that of conventional bonds.

we select a probability distribution of returns. Under certain assumptions, it is possible to focus on only two parameters of the portfolio's rate of return probability distribution: its mean (expected return) and its variance (as a measure of risk). That is the reason why the Markowitz model is known as the mean-variance approach.

- 10 In 2007, the European Investment Bank issued the first green bonds and raised €600 million in financing, and in 2008, the International Bank for Reconstruction and Development joined the issuance of green bonds. Until 2013, only international agencies or multilateral development banks issued assets of this type..
- 11 It is important to note that, since green bonds are compared with conventional bonds similar in terms of maturity, coupon type and issued by the same issuer, there are no differences between them as regards their risk (it is also common to adjust for liquidity). This is why the papers cited above focus solely on comparing their returns. However, Gimeno and Sols (2020) point out that, while there are no differences in credit risk, there may be differences in climate risk, being higher in conventional bonds, which could help to explain why they have a higher profitability. Adjusting for climate risk would therefore be essential for comparing returns, although it is a complex task since, as we shall see in section 5, measuring climate risk is not an easy task.
- 12 The importance of external certification is also picked up by Hyun et al. (2020), who find that while, on average, there is no significant difference in the premiums of green bonds compared to conventional bonds, there is a significant difference in favour of green bonds when they are certified by an external agency.



The role of preferences

If the green bonds returns are not clearly higher than those for conventional bonds and they show a similar risk (without taking climate risk into account), then what explains their inclusion in the investors' portfolios? The answer is the existence of non-pecuniary arguments in the investors' preferences, in line with the work by Fama and French (2007). The essential idea is that investors' utility when selecting portfolios depends not only on the risk-return combination that they generate, as the traditional approach suggests, but on other elements as well; in the case of sustainable financial assets, investors take into consideration whether the economic activity of the companies in which they invest is socially responsible or follows ethical or ESG criteria, since this makes them feel like better citizens (Gillan et al., 2021). Financial assets, therefore, are not only the instrument that allows economic agents to allocate their resources over time, but they also enter into their preferences, generating utility from the mere fact of being or not being a "sustainable" asset.

In the same line, recent works have incorporated ESG indicators in the analysis of investor decisions as well as in asset pricing models. For example, Pedersen et al. (2021) consider that a company's ESG indicator not only provides information on its fundamentals, but also affects investor

preferences. In their model, investors concerned in ESG criteria (ESG-motivated investors) show a preference for companies with higher ESG scores. These investors look for portfolios with the optimal trade-off between high return, low risk and high ESG score. For each ESG score, they calculate the maximum achievable Sharpe ratio (this ratio allows to determine the compensation in terms of return per unit of risk), generating what they call the efficient frontier of ESG portfolios, which in this case is a combination of (i) the risk-free asset, (ii) the tangency portfolio (i.e. the one that maximises the Sharpe ratio), (iii) the minimum risk portfolio and (iv) the ESG tangency portfolio, that is, it is the result of combining four funds⁽¹³⁾. The main conclusion of the work in this regard is that, if there are many ESG-motivated investors in the economy, assets with high ESG scores generate low expected returns, since investors sacrifice returns in exchange for "sustainability-friendly" portfolios⁽¹⁴⁾.

In the same line, Pastor et al. (2021a) show that investors who take ESG criteria into account demand lower returns on green stocks, since they not only increase their returns, but also allow them to hedge against climate risk, so they would have a negative climate risk premium. However, in a later empirical work for the last decade, Pastor et al. (2021b) find the opposite result, that is, a higher realised return for green bonds, which could be explained by an increase in demand for this type of assets as a result of greater investors' environmental awareness.

The fact that some investors might be considering sustainability as an additional variable when selecting their portfolio would imply that the investment base is not the same for all assets, but would depend on the trade-off between lower profitability or higher risk, on the one hand, and greater sustainability on the other hand. In this respect, the literature identifies different investment strategies that take into account different sets of assets (and, therefore, establish different efficient frontiers depending on the assets considered), ranging from the so-called exclusion strategies (which eliminate from the set of eligible assets those that are not sustainability-friendly,

13 We moved from the Two-Fund Separation Theorem (risk-free asset and tangency portfolio) of the traditional model to a Four-Fund Separation Theorem (adding the minimum risk and the ESG tangency portfolios to the two previous funds).

14 The model is able to explain the apparently contradictory results of previous works by considering different types of investors in terms of their concern for ESG indicators.



potentially sacrificing, at least partially, the advantages of diversification) to other more committed actions that seek to influence the behaviour of companies in terms of sustainability, making use of the control rights that ownership entails (we shall discuss these in the section on issuers)⁽¹⁵⁾.

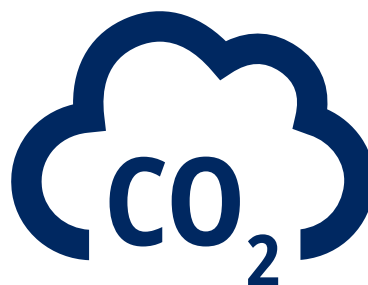
The green factor

Regarding the asset pricing models, Pedersen et al. (2021) derive a CAPM-style equilibrium model⁽¹⁶⁾ but adjusted for ESG, that is, adding ESG risk as a systematic risk factor in addition to the market risk of the traditional model. In the same line is the work by Bolton and Kacperczyk (2021), who find that shares of US companies with higher carbon emissions pay higher returns, which is understood as a higher risk premium demanded by investors (i.e., a “carbon premium”) for the additional risk they assume by holding them in their portfolios. This is the line of the work of Alessi et al. (2021) who find, for European companies, that those firms that emit less greenhouse gases, and are also more transparent providing information on their environmental commitment, have a clearly significant negative premium (i.e. investors are willing to accept a lower return for them), which is understood as a strategy to hedge against greater transition risks in the future

Diversification

An additional reason that could lead investors to include sustainable financial assets, and which has also been analysed in economic research on the subject, is that they would allow for better diversification of their portfolios (i.e., their incorporation in their portfolios would reduce their risk).

The papers by Reboredo (2018), Broadstock and Cheng (2019), Reboredo and Ugolini (2020), Reboredo et al. (2020) and Nguyen et al. (2021), among others, are some examples of analysis of the relationships between green bond markets, traditional bond, equity markets and energy-related commodity markets. The empirical evidence presented seems to show a close link between the green



and could also reflect a greater “green preference” in accordance with the results of above-mentioned papers. They derive this negative risk premium from standard asset pricing models: in addition to the classical CAPM model, they use the three-factor model of Fama and French (1993) and the four-factor model of Carhart (1997), adding the “green factor”.

Gimeno and González (2022) also build a “green factor” based on the carbon emissions of both US and European companies which is included into the five-factor model of Fama and French (2015). They find that it provides relevant information on excess return on equity, which cannot be explained only by the other market factors considered and that the “green factor” has changed over time, being higher when regulatory advances have been made in the fight against climate change.

bond market and the “conventional” bond market (except for high yield bonds that, due to their characteristics are closer to the behaviour of equities), the latter being the ones that determine the price evolution of green bonds. On the other hand, the advantages of including green bonds in portfolios made up of shares or commodities are evident in terms of reducing their risk, given the low or negative correlation observed between green bonds and the aforementioned assets. Therefore, it should not be ruled out that the improvement in the investors’ portfolios diversification is an additional reason to explain why investors demand sustainable financial assets. To summarize, the emergence of sustainable finance implies, from the investors’ perspective, a reconsideration

15 Other intermediate investment strategies are (i) the impact investing, based on portfolios that invest in projects with a positive impact on sustainability, (ii) the integration of ESG criteria investing, that implies the incorporation of sustainability in the portfolio selection or (iii) the best-in-class investing, which consists of including in the portfolio assets of those companies with the highest sustainability factor within each sector or industry.

16 See Sharpe (1964), Litner (1965) and Mossin (1966).

of the theoretical framework of the portfolio selection theory, both in terms of their preferences (which could lead investors to select “sustainable” financial assets even if their risk-return ratio is less attractive) and the set of efficient portfolios (which would be built considering not only the risk and return of the portfolios, but also ESG-type criteria). This is also linked both to the potential existence

of different investment bases for different financial assets depending on their sustainability position, and to the need to incorporate a new systematic risk factor related to climate risk into asset pricing models (the so-called green factor). In short, the academic literature is immersed in an intense process of incorporating sustainability into the models that explain the investors’ behaviour.

3. Sustainable Finance: The Issuers

The incorporation of sustainability in financial markets can affect issuers through the two key variables of funding: the

cost at which funds can be raised and the amount of funds that can be raised.

The cost of capital and funds to finance the sustainability of issuers

With regard to the cost of capital at which the company is financed, the sustainable commitment of an issuer (understood in terms of compliance with CSR and ESG criteria or the consideration of related risks not previously taken into account) could favour cheaper financing. And why would the cost be lower? One reason would be that the market would have included climate risk or other non-financial and financial risks related to sustainability into the risk premium, so that those issuers better prepared to deal with such risks would be required to pay a lower premium and the cost of borrowing would therefore be lower⁽¹⁷⁾.

Several empirical studies show that companies that have adopted sustainability strategies or policies have a lower risk than those that have not. In the case of companies in the financial sector, a study by the Global Alliance for Banking on Values (2016) compares a group of sustainable banks with another group of banks of global relevance during the last international financial crisis (2006–2015). The results show how the financial risk (in standard deviation) of sustainable banks was significantly lower: 4.9% compared to 7.7% for the group of relevant banks (the difference between the ROEs being much smaller: 8.3% compared to 8.7%). Ortiz-de-Mandojana and Bansal (2016)

compare 121 US financial and non-financial companies with sustainable corporate policies to 121 companies with similar characteristics that do not apply such policies, and conclude that, in the long term, the former show higher growth of net sales and lower volatility in returns than the latter⁽¹⁸⁾. According to these authors, this result shows that companies with policies committed to sustainability are able to perceive and adapt to the problems in their environment, which contributes to increasing their degree of resilience and, therefore, their capacity for recovery.

Another reason that can help reduce the cost of capital is the growing segment of the market (the investor base) that prefers to invest in companies or projects classified as sustainable. As we have seen in the previous section, certain investors, either due to a change in preferences or because the overall risk-return ratio of the product is optimal, have a specific demand for these kind of sustainable financial products (form a differentiated investor base). The literature review, both theoretical and empirical, that is carried out by Gillan et al. (2021), seems to confirm this reason: a higher valuation of companies in terms of ESG (especially E is discussed) or CSR ratings attracts a certain “sustainable” investor base, which explains their lower cost of financing (e.g. Heinkel et al.

17 As already mentioned, the introduction of sustainability in financial markets has highlighted the need to include other existing risks not traditionally considered when valuing projects, essentially climate risk, which is evident mainly in physical and transition risk. The World Economic Forum (WEF) emphasizes in its 2019–2020 annual report the importance, in terms of probability of occurrence and impact, of this type of environment-related risks. The influence of this type of risk on financial risk is discussed in section 5.

18 Gittell et al. (2006) obtain a similar result with regard to volatility.

2001; Hong and Kacperczyk, 2009; El Ghouli et al., 2011), either through the issuance of fixed income or equity. However, more recent work highlights the importance of analysing ESG criteria separately due to the potential conflicts of adding environmental (E) with social (S) and governance (G) criteria (Pollman, 2022; Edmans, 2022). As Edmans (2022) points out, certain projects can favour a good rating with respect to the environmental criterion (E) and, at the same time, be negative in the social sphere (S)⁽¹⁹⁾. Thus, when disaggregated, Ng and Rezaee (2015) find that the relationship between higher ESG commitment and lower financing cost exists to the extent that the environmental (E) or governance (G) criteria are used, but is not observed when social (S) criterion is used. Breuer et al. (2018) also obtained a negative relationship between the cost of capital and investment in environmental activities, but only if the legislation of the issuer's country strongly protects investors. Conversely, the cost of capital will be higher when investing in

socially oriented activities in countries with a low level of investor protection⁽²⁰⁾. In sum, there is empirical work that supports the idea that issuers that adopt CSR strategies and/or are better qualified in terms of compliance with one or more ESG criteria (E and G especially) will be able to obtain funding at a lower cost (when there is strong legal backing for investors in the country) compared to companies or projects that are less involved with sustainability. But how could a company send to the market the information of its commitment to sustainability in order to obtain these funds at a lower cost? We address this issue below.



Signalling the company's commitment to sustainability⁽²¹⁾

In financial markets, investors do not have perfect information about this characteristic of the company, there are information asymmetries, with the issuer having more information about its "sustainability quality". In order to obtain the "sustainable purpose" savings segment or/and financing at a better cost, issuers will be willing to communicate to investors their commitment to sustainability, both of the company and of the projects to be financed, provided that the benefit of making that information public outweighs the cost of disclosure. The way to be identified as sustainable would be to carry

out an activity or make a decision that would make that commitment credible to investors, so that they would prefer to invest in that company. This information can be provided directly by the company to the market, e.g. by issuing financial products with sustainable "labels"⁽²²⁾ (such as green bonds) or publishing audited sustainability reports. This way is discussed at length in the next section on financial regulation of sustainability. But there is also an indirect way that allows the issuers to reveal their "sustainability quality" to investors, by sending signals to investors about what is

19 This wake-up call is also felt in the markets: a recent report in the Financial Times (31/08/2022) stated that Util (an advisory and research company), after analysing around 6,000 US investment funds, concluded that the use of this aggregate criterion to qualify investments as good or bad is not adequate to satisfy investors' preferences when deciding the composition of their portfolios.

20 The legal tradition that governs a country is fundamental to explain the degree of CSR commitment of a company, as concluded by Liang and Renneboog (2017), who show that countries governed by civil law have more restrictive laws ex ante with the behaviour of companies, in comparison with countries under common law, since the former are associated with social preferences that give greater value to stakeholders (such as workers, clients, etc.) than to market mechanisms (common law) to control company policy. Thus, the result of Breuer et al. (2018) would indicate that the lower cost of capital is related to legislation that makes the company's CSR commitment or compliance with ESG criteria credible. Another approach to the effect of country characteristics (laws, culture, economic development) on the explanation of companies' ESG ratings can be found in Cai et al. (2016).

21 For simplicity of exposition, we will consider the terms sustainable engagement, CSR and compliance with ESG criteria as equivalent, as expressed by Larcker et al. (2021), Gillan et al. (2021) or Dolsaket al. (2022), despite the conceptual differences between these terms. While sustainability is directly related to a company's long-term objectives and CSR to ethical or moral criteria, ESG criteria originally have a financial dimension insofar as they function as a tool to identify certain investments and manage risks (Pollman, 2022). LoPucki (2021) connects these terms by considering CSR as the abstract idea that the company has a moral responsibility to voluntarily integrate ESG-type improvements into the company's economic activity to benefit both shareholders and other stakeholders, society at large and the environment.

22 In fact, Flammer (2021) concludes that it is the signal that issuers send to the market about the company's true commitment to sustainability that leads them to opt for this form of financing.

not directly observable. An essential mechanism to signal this commitment may be the type of board of directors of the issuer. The board is the main governing body of a company and plays a key role in the strategic orientation of the firm and therefore in the decision to integrate (or not) CSR considerations among its strategic objectives (Endrikat et al., 2021) or commitment to ESG criteria, its current equivalent according to Bosetti (2019).

Various works in the theoretical and empirical literature investigate the relationship between the composition of boards and their sustainability rating (which incorporates the company's reporting and signalling regarding sustainability). In particular, the characteristics of certain significant shareholders (those with influence or decision-making power on the board of directors) are examined.

From a theoretical perspective, Gollier and Pouget's (2022) model examines the conditions under which socially responsible investors (those who take into account the externalities generated by a company when making their investment decisions) can induce companies to behave responsibly with their vote. By means of an asset valuation model, in which the share price partially incorporates these externalities, they find that the conflict of interest that would arise between the company's shareholders over the lower financial return that a responsible strategy might entail is resolved in favour of social responsibility, provided that the positive externality it entails and the proportion of responsible investors are both sufficiently high, and the risk aversion of investors and the level of risk are sufficiently low. When this is not the case, in equilibrium, the purely financial strategy is adopted after the vote.

These results reveal some of the difficulties of making responsible investments, which seem to be highlighted by the findings of Menz (2010) and Hirst (2018), who show that this type of shareholder activism has limited success when it comes to influencing the behaviour of companies.

In the empirical literature, the analysis has focused mainly on the role played by a certain type of significant shareholders: institutional shareholders (investment funds, pension funds, insurance companies, etc.). The results are inconclusive. On the one hand, some studies do find a higher rating or involvement in the sustainability of companies when they have among their significant

shareholders an institutional type committed to the long-term corporate policy of the investee. On the one hand, some studies do find a greater rating or involvement in the sustainability of companies when they have among their significant shareholders an institutional shareholder committed to the company's business policy in the long term. (Dimson et al., 2015; Barko et al., 2021; Hoepner et al., 2019; Naaraayanan et al., 2021; Cao et al., 2019). Thus, Hoepner et al. (2019) show that companies issuing green bonds benefit from having institutional investors among their significant shareholders, as they reduce their financial risk when the market falls (downside risk) because they are investors with a long-term investment time horizon who would prefer to maintain their equity positions in ESG-compliant companies and act patiently when they incur losses, as the company's compliance with ESG criteria provides them with a kind of insurance against potentially risky or harmful investments and reduces the likelihood of lawsuits against the company by its stakeholders or the authorities. For institutional investors, Gordon (2022) also stresses the positive effect of considering ESG factors to the extent that they reduce systemic risk in their portfolios (the so-called green factor from the investor's perspective).

Other work shows that there is no clear positive relationship between a better company rating and the significant presence of institutional shareholders in the company (Borghesi et al., 2014; Nofsinger et al. 2019). According to Fernando et al. (2017), this result is due to the fact that this type of shareholder is more frequent among companies in the middle range of sustainability ratings than among those with better and worse "grades". According to Hong and Kacperczyk (2009), the cause of this lack of positive relationship is to be found in the legal restrictions to which institutional investors are subject. Thus, those with more restrictions, such as pension funds, are those that tend not to include in their portfolios financial products with low ratings, while investment funds or hedge funds, which have fewer restrictions when constructing their portfolios, are less demanding. For Starks et al. (2019) it is the time horizon that is the differentiating factor: institutional investors with a long-term investment horizon are the ones who decide to invest to a greater extent in companies with higher sustainability commitments. In sum, the positive role of institutional shareholders in terms of sustainability seems to be linked to the time horizon of their investment, which makes their



commitment to the sustainability strategy adopted by the company more credible⁽²³⁾.

The influence on the sustainable performance or behaviour of companies of other types of significant shareholders, such as families or the public sector, has also been analysed. In the case of family-type shareholders, the results are mixed: while for the US case it seems to improve (Abeysekera and Fernando, 2020), for the Sweden case it would only improve in the case of considering criterion E (environmental), but not when it comes to criterion S (social) (Gillan et al., 2021). In the case of a sample of family-controlled companies from nine Asian countries, not only is this result not confirmed, but the opposite is proven (El Ghouli et al., 2016). Regarding the role of the public sector as a significant shareholder, the results are, for now, conclusive: state-owned companies have a positive role in terms of their involvement in improving the sustainability (according to ESG criteria) of their productive activities (Hsu et al., 2021; Boubakri et al., 2019).

There is also empirical work that studies the opposite relationship, i.e. whether companies with better sustainability ratings (either in CSR or ESG terms) are the ones that attract a certain type of significant shareholder. In other words, whether signalling that the company has a responsible or sustainable social policy induces changes in the shareholder composition of the issuing companies and, therefore, in the composition of their governance. In general terms, empirical studies show that the participation of institutional investors in companies issuing green financial products increases significantly. As an example,

the work of Tang and Zhang (2020), who, based on a study carried out on the issuance of green bonds in 28 countries from 2007 to 2017, find that, when comparing the shareholder composition of companies issuing green bonds and those issuing only conventional bonds, the former show an increase in ownership by domestic institutional shareholders of around 8%. According to these authors, the reason for this is that by issuing green bonds, issuers are more exposed to the media and thus increase their visibility in the media. This allows them to attract more attention from investors, which may result in increased demand for their shares.

Finally, based on the results compiled by Gillan et al. (2021), the prototype board of the companies with the best sustainability ratings can be traced. This board would be composed of members from different countries, with younger CEOs and lower salaries than those of lowest-rated companies⁽²⁴⁾. It also stresses the importance of women holding prominent positions in the company, whether on the board or in the management.

Sustainability as a company objective

Another way to signal the company's commitment to sustainability is to explicitly include sustainability criteria in the company's objectives. This point is particularly complex to deal with and, at the same time, highly topical in the academic world. It is complex because it questions, from the perspective of Political Economy (Salas, 2021), the very theoretical firm model of Neoclassical Economics (the one studied in Microeconomics), in which its objective is the profit maximisation or, in other words, the maximisation

23 The long-term investment commitment, together with the achievement of good governance and transparency, are the main requirements of investor codes of good practice adopted in various countries (as in the case of the United Kingdom) or in the process of being developed in others (as in the case of Spain). In the case of most European countries, the question arises as to whether these recommendations should be extended to controlling shareholders (Salas, 2022), given that the shareholding distribution of major listed companies is not in the hands of institutional investors (see Puchniak, 2021).

24 This result is not unanimous, since some studies find no relationship between these variables (Borghesi et al., 2014; Masulis and Reza, 2015).

of shareholder wealth. The reason for this questioning lies, as this author points out, in the inability of governments to deal with progressive environmental degradation and growing inequality, given the global scope of these negative externalities. Consequently, and from normative proposals (“how the company should be”), an attempt is made to involve companies to also take certain objectives or purposes in order to mitigate these market failures. Thus, the maximization of integrated value would be an alternative objective of companies. This objective combines financial value with social and environmental value, where, in addition to shareholders, stakeholders are taken into account in equal importance, and it is set and evaluated in the long-term (Kurznack et al. 2021). This proposal for “reform” of the company’s objectives presents different approaches, depending on the priority given to shareholders and the degree of regulation involved⁽²⁵⁾.

When it is proposed to implement this objective from a model based on decisions not only of shareholders but also of stakeholders, an essential question arises: Is it feasible to manage the company including the stakeholders’ objectives in addition to wealth maximization (shareholders’ objective)? This idea is supported by Magill et al. (2015), for whom maximising the integrated value of the company implies the introduction of new ownership rights over the company, such as the rights of employees and consumers, something that, traditionally, has been reserved exclusively for shareholders. Mehrotra and Morck (2017) show that this kind of “overarching” objective can lead to many situations in which a clear conflict between the interests of shareholders and different stakeholders arises. Tirole (2001) considers three potential problems that would affect: (i) shareholders, as this type of model may reduce the income available to them, as the cash flows generated would be distributed among several stakeholders; (ii) the managers, as having to “serve multiple masters” may make their mission less clear and reduce their incentives; (iii) the company, since control divided among multiple stakeholders may lead to a deadlock in decision-making.

Salas (2021) goes a step further and considers whether the company itself is viable with this change of objective, since, in an environment of perfect competition, assuming objectives other than maximising shareholder wealth implies incurring costs that might not be compensated by a greater willingness

to pay on the part of consumers. If this were the case, the company’s viability could be threatened. Only if the context is not one of perfect competition or if a shift in preferences towards sustainability on the supply and demand side takes root, would the company survive.

If the model in which the goals of shareholders have pre-eminence in decision-making is maintained, sustainability should be supported by pro-social shareholders, that is, a kind of shareholder that seeks to maximise financial value while satisfying shareholder welfare, including social and environmental externalities (Hart and Zingales, 2017). In this case it would be necessary that their votes could guide the corporate policy towards sustainability, as we saw in the theoretical model of Gollier and Pouget (2022) in the previous section. This reform of the model would fall within the scope of self-regulation.

But there are proposals to improve corporate governance in terms of sustainability that go beyond self-regulation, without challenging the hegemony of shareholders. In this line we find the legislative initiatives presented by the EU, such as the requirement to publish sustainability information reports (also called non-financial information) in the near future audited. If we move on to the degree of regulation on the objective that the company should have, we find proposals to reform company law and oblige companies to be incorporated with a “social purpose” (such as the B-corporation in the United States or the *société à mission* in France), with the profit and purpose of the company being on the same level when managers are taking the decisions. This is a proposal by The British Academy in 2018 and Mayer (2018, 2020). Mayer, as the head of this initiative, proposes the following definition of corporate purpose: “producing profitable solutions for the people and planet” and “not profiting from producing problems for the people and the planet”. This proposal seeks to achieve the social purpose as an objective, the restrictions being private profitability (avoiding economic losses) and refraining from activities whose social profitability is negative (Salas, 2021). The initiatives to reform Corporate law go even further than the requirement of a social purpose, and range from requiring directors to be trustees of the company’s purpose rather than representing shareholders, to mandating the inclusion of employee representatives on company governing boards, as already exists in some economies, such as the German one.

25 For further development of the proposals, see Salas (2021).

Therefore, the impact of sustainability on issuers goes beyond mere signalling as a way for the company to raise more funds at a better cost, and could even promote the

emergence or spread of new corporate forms and affect company law.

4. Sustainable Finance: The Regulators

As we have seen in the previous sections, the rise of sustainable finance has led not only to the redefinition of existing financial products and the emergence of new ones, but also to the need for their issuers to credibly demonstrate to investors that the funds provided by them will be used for the purpose related to the sustainability of the economy for which they were requested. In the previous section we discussed how the company can signal this commitment through its corporate governance, for example through a certain composition of its board of directors or the purpose of the company itself. But it can also signal that it complies with its commitment, in its objectives or the destination of the funds, by providing information or guarantees of its compliance.

There are several ways of passing on this information, from the issuance of financial products that allocate resources to projects labelled as sustainable (green bonds, blue bonds, social bonds, etc.) to the publication of reports that specifically communicate information (of a non-financial nature) on social, environmental or governance issues. The first sustainability reports appeared in the 1970s with a focus on social issues, moving on to reporting on environmental issues in the 1980s. (Stubbs and Higgins, 2018)⁽²⁶⁾. Today's sustainability reports provide much more information as they integrate the Corporate Responsibility Report with the Non-Financial Information Statement. A large part of this information, especially with regard to the relative criterion of corporate governance (G), was already being transmitted since the Codes of Good Governance appeared at the end of the 20th century, and later with the successive revisions and extensions that they have undergone. Therefore, for large companies, and especially for listed companies, reporting on non-financial issues related to sustainability is not new.

However, there is a fundamental problem: there is no single definition of a sustainable product or company, nor is any

of the existing ones generally accepted, which allows the so-called greenwashing to emerge. This term has multiple definitions, as stated in de Freitas et al. (2020) (27). One is from the Concise Oxford English Dictionary (2018) which defines it as "a public image of environmental responsibility promulgated by or for an organization, etc., but perceived as being unfounded or intentionally misleading" (28). It is therefore a question of using an image of sustainability that in practice is either incomplete, or wholly or partially false, with the negative consequences of increased scepticism and confusion among investors. As a consequence, the volume and the lower cost of sustainable financing may be penalised and, ultimately, the environment itself would be harmed, as "compliant" companies would be less motivated to respect their environmental commitment (Gatti et al., 2019). This raises the debate on who determines the sustainability of a company or financial product and whether the information provided is voluntary for companies or should be mandatory by law. In other words, whether the rules and their enforcement are dictated by the market itself (self-regulation) or whether this should be done through the enactment of laws or directives and the supervision of public authorities.

The work of Park (2018) shows the advantages and disadvantages of private regulation (self-regulation) of sustainable finance from the perspective of investors. Thus, he points to the advantages of self-regulation as being speed and responsiveness in meeting the needs of financial market participants. This type of regulation is based on quantitative indicators, sectoral benchmarks, good practices or voluntary reporting initiatives by companies, such as the sustainability reports mentioned above. The self-regulatory response to avoid greenwashing in these reports has come from different market institutions promoting the use of procedural, reporting and certification standards that allow companies to credibly disclose their

²⁶ As a reference in the academic literature, we can go back to 1994, when J. Elkington coined the term "triple bottom line" (TBL), a proposal to evaluate the results of a company not only from the traditional economic-financial perspective, but also from the social and environmental perspectives. The aim is therefore for the company to have a triple bottom line and thus to be able to know and report on the degree of compliance of the company's activity with sustainability.

commitment to sustainability. Among the proposed standards, the Global Reporting Initiative (GRI), the most widely used form of self-regulation since 2000, seeks to create a common language for organisations to make this information available to society. These reports are based on ISO 14001 (Mitchell and Hill, 2009), which since 1996, with subsequent modifications, has made it possible to certify the environmental commitment of organisations. According to the GRI, by geographical area, the largest number of corporate reports during the 1999–2017 period came from Europe and Asia, although in Europe the growing trend has reversed in recent years. In North America, except in the case of multinationals, the low number of such reporting is notable. In contrast, in Latin America and Africa, they are increasingly being presented (Halkos and Nomikos, 2021).

Despite the predominance of the standard proposed by GRI, Koerber (2009) estimates that there are more than 300 standards dealing with different aspects of corporate social responsibility (such as working conditions, human rights, environmental protection, transparency, etc.). There is some overlap between these standards, as each of them is designed to meet the explicit requirements of different stakeholders (governments, trade unions, civil associations, etc.). For example, the work of Halkos and Nomikos (2021) points out that the application of the GRI standard in developed countries is explained by the pressure exerted by governments pressure.

Regarding the question of how to ensure that the financial products issued meet the criteria for being sustainable, the self-regulation or “market” solution was initially provided by the Climate Bonds Initiative, which in 2013 published its taxonomy, a methodology for selecting bonds that meet its sustainability criteria, giving them a stamp or label and monitoring compliance with the criteria. Subsequently, in 2014, the ICMA (International Capital Market Association) published the Green Bond Principles, establishing a series of guidelines that these financial products must comply with in terms of the use of the funds, the evaluation of the projects they finance, the management of the funds obtained with the issue, as well as the disclosure of information by the issuer regarding the resources obtained and the projects they finance. Self-regulation also involves other types of actors, such as rating agencies, which assess compliance

with ESG criteria and have been performing their role since 2005⁽²⁷⁾.

Although for some authors the self-regulatory solution provides significant advantages over public regulation (La Torre, 2020), it also suffers from various deficit (Park, 2018). On the one hand, private standards defining the degree of sustainability of a firm (on any of the ESG criteria) may lack legitimacy, accountability and consistency. Thus, the lack of legal authority (and the sanctioning component) and the voluntariness of companies to meet these standards and publish sustainability reports means that self-regulation compliance is essentially based on reputation (based on self-interest or the belief that “the right thing is being done”) and/or control among stakeholders. On the other hand, the existence of different standards can encourage companies to engage in regulatory arbitrage, that is, to select the one that is most beneficial or suited to their interests. Gatti et al. (2019), after analysing 94 academic papers on greenwashing, conclude that self-regulation and voluntary compliance with rules facilitate the spread of greenwashing. Regarding rating agencies, Escrig-Olmedo et al. (2019) point out that, although they have been improving their measurements by including new criteria in their models, they are still far from fully integrating sustainability principles in the process of assessing the sustainability of companies. The lack of consensus in their ratings is also criticised (Berg et al. 2022), which can lead to confusion for investors. Edmans (2022) argues that, after all, agencies issue opinions that depend on a number of factors they consider relevant, factors whose weighting in the effect on the long-term value of the company also differs. All this could explain the discrepancies between the ratings issued by the different agencies.

Despite the rapid self-regulatory response and development of this new financial services industry “for sustainability”, public regulation has been “taking over” the regulation of this niche market niche in recent years. It is the case, for example, of the EU, with the 2018 EU Action Plan for Financing Sustainable Growth, the EU Taxonomy Regulation 2020/852 (which classifies economic activities on the basis of their environmental sustainability) or Directive 2014/95/EU on disclosure of non-financial information and diversity information, which requires certain large companies and

27 In particular, the items assessed by ESG rating agencies in section G on corporate governance (as in the case of S&P Global) are largely based on the standards proposed by the GRI in this regard and on what is contained in the Codes of Good Governance of the different countries.

groups (with more than 500 employees) to disclose information on the social and environmental impact of their activities, their governance and sustainability risk management. With the recent approval (in November 2022) of the Corporate Sustainability Reporting Directive in the EU, the level of detail in the information that companies are required to provide increases compared to that required by Directive 2014/95/EU. These new rules will be implemented in stages from 2024 to a much broader range of companies than those subject to the Directive so far, as other large companies (with more than 250 employees and/or EUR 40 million turnover and/or EUR 20 million total

But the EU initiative would in principle affect only part of the financial markets. The problem that arises, then, is that of regulatory plurality at the international level, which can lead to conflicting legislation, arbitrage possibilities for investors, market fragmentation, uncertainty among participants and lower levels of compliance (Park, 2018)⁽²⁸⁾. An important advance in the international coordination of existing taxonomies is the creation by the EU of the International Platform on Sustainable Finance, in which countries such as China, Morocco and Canada take part (Romo, 2021).



assets) and listed small and medium enterprises will also be required to disclose this information, although the latter may choose to start making it public later. Legislation of this kind seeks to clarify the language used in this segment of the financial market and to establish common criteria for classifying economic activities, while at the same time increasing, at the same time, the degree of commitment and accountability of boards of directors.

What solution, then, regulates sustainable financial markets? What is currently observed is a mixture of private standards that sometimes operate independently and sometimes in conjunction with national regulation or that of international organizations (Park, 2018). According to this author, one way to address the governance deficit in these markets would be through the hybrid option, identifying sources of complementarity between public and private

²⁸ Various documents, such as that of the Bank for International Settlements (2021a), which compares the taxonomies proposed by the European Commission, China and the Climate Bond Initiative, or that of the OECD (2020), which compares the proposals of China and the EU, as well as those of France, Japan and the Netherlands, suggest the need for consensus on a taxonomy and propose a series of recommendations to this end.

regulation. An example of this option would be for public regulation to establish minimum standards to be met by private regulation or for external audits to be mandatory as a means of encouraging compliance with private standards, among others. This seems to be the approach taken.

To summarize, the rapid self-regulatory response of the financial sector to the new issues raised by sustainability in terms of the information provided by issuers and compliance guarantees, has been gradually ceding part of its regulatory room to public regulations that seek to legally establish minimum information requirements for

companies as well as the adoption of a common language. As a result, regulation today consists of a conglomerate of private standards and national and international regulations that sometimes complement each other and sometimes “crowd out” the former by imposing certain obligations on issuers. Nevertheless, the previous self-regulatory line taken by large listed companies facilitates a “smooth” transition to a publicly regulated environment (31). However, the transition for small and medium-sized enterprises is expected to be more costly and complex (Gholami et al., 2022).

5. Sustainable Finance: The Supervisors

Having considered some of the issues of sustainable finance which, from the academic literature, are considered most relevant both for investors and issuers and regulators, we now focus on some of the challenges they pose for the supervisors in charge of ensuring the financial stability of the system. Specifically, we will focus on the supervisors of credit institutions. Therefore, we analyse how climate risk is incorporated into financial risks and what alternatives for its measurement are being proposed.

Climate change poses several financial risks arising from its potential effects on firms, households, banks, financial markets, and the economy in general. To the extent that these risks are global and systemic in nature (given the international connectedness of financial markets), it is understandable that both regulators and supervisors of banks and other financial institutions should pay attention to them and warn about their potential impact on financial stability. In particular, following the speech given in 2015 by the Governor of the Bank of England, Mark Carney⁽²⁹⁾, central banks are beginning to show concern about these new risks in addition to those traditionally considered. As a result of this concern, in December 2017, after the Paris summit, the Network of Central Banks and Supervisors for Greening the Financial System (NGFS) was created. It was initially composed of 8 members, and by October 2022 of 121 members (most of them central banks), in addition to 19 observers. Its objective is to develop initiatives and

promote good practices that enable the financial system to adequately manage the risks derived from climate change in the different possible scenarios (NGFS, 2020), as well as to channel the necessary resources to finance the transition to a low greenhouse gas emission economy.

As already mentioned, it is common to identify two types of climate-related risks: physical risk and transition risk⁽³⁰⁾ (Carney, 2015). The first is associated with the effects produced by meteorological phenomena linked to climate change, such as floods, hurricanes, droughts, fires, rising sea level, etc. As regards transition risk, as its name suggests, refers to the risks arising for banks, firms and the economy as a whole from the transition to a decarbonised economy. These risks may stem from changes in regulation (e.g. as a result of the introduction of taxes on polluting companies or limitations on greenhouse gas emissions), from technological changes necessary to carry out that transformation (the shift from fuel-based transport to electric or similar transport systems may be a good example) or from changes in consumer and investor preferences, which penalise companies less committed to the objectives of combating climate change. Physical and transitional risks are interrelated. Thus, for example, the adoption of measures at the present time to reduce physical risk in the future may increase transition risks. However, delaying such measures would ultimately lead to increased physical risk.

29 See Carney (2015).

30 It is also pointed out the risk of liability or litigation, which refers to the possibility that agents affected by climate change losses may seek to recover those losses from those they consider responsible for them, either through litigation or through insurance claims.

Climate risks and financial risk

From the point of view of supervisors, what is relevant is that both physical and transition risks could become financial risks. While both could affect all economic agents (households, firms, governments, financial institutions, etc.), the maintenance of financial stability depends to a large extent on how well credit institutions are able to manage

these risks. In this regard, the Basel Committee on Banking Supervision considers that financial risks related to climate change can be included within the traditional typology of risks faced by banking entities: credit risk, market risk⁽³¹⁾ and liquidity risk (BIS, 2021b)⁽³²⁾, which are clearly related to each other.

Credit risk

Physical capital (housing, property, infrastructure) can be damaged by physical risks, negatively impacting the cash flows of households and firms, thereby. This may make more difficult for both agents to repay the loans contracted and may reduce the value of the collateral used, thus increasing the credit risk faced by banks. But transition risks can also increase credit risk, especially in sectors that need to adapt to changing regulations or preferences. An obvious example is the automotive sector, in which the probability of defaulting on debts may increase if sales (if they fail to adapt to changing consumer preferences) and profitability (if they

face higher costs to comply with regulations) are reduced. Another example would be that of oil extracting companies, since meeting the objectives of the Paris Agreement to limit the increase in temperatures would require leaving the reserves of this fossil fuel unextracted (Matikainen, 2018), making it a “stranded asset”. In addition, several studies show that the most polluting companies have a higher probability of default, among others that of Capasso et al. (2020), who find that this probability, measured using the Merton (1974) model, is higher as a result of the Paris Agreement for companies that emit more CO₂.

Market risk

On the other hand, both physical and transition risks could affect the prices of financial and real assets. An unanticipated fall in these prices would affect the market risk of banking entities (meaning, in this context, the risk derived from the loss of asset value) if they have such assets on their balance sheets⁽³³⁾. This risk will logically be lower insofar as that asset prices are already, to some extent, discounting climate risks. The academic literature on climate risks and asset valuation is still in its infancy, albeit rapidly developing. This literature would fall into the area that some authors have called “climate finance” (as is the case of Giglio et al., 2020), in which the links between climate change and financial economics are analysed.

Several empirical papers have been published in recent years assessing whether climate risks are already being reflected in asset prices. For example, Goldsmith-Pinkham et al. (2021) and Painter (2020) suggest that the long-term maturity municipal bonds from US towns most exposed to flooding from rising sea levels offer superior returns to their investors. There is also some evidence that housing prices in these locations are at a significant discount to those of similar characteristics in other areas (Bernstein et al., 2019). On the other hand, some sovereign bonds could also be discounting climate risk; Cevik and Jalles (2020) find that bonds from countries with greater vulnerability to climate change pay a higher interest rate. However, there

31 Market risk here refers to price risk, i.e. the risk that the price of the assets in the negotiated portfolio will decline, rather than market risk as a systematic risk factor as used in asset pricing models.

32 These are the main categories of financial risk, but operational and reputational risk are also present. In regard to the first one, its connection with physical risk is evident: if natural disasters, for example, damage telecommunications infrastructure, the operations of credit institutions would be affected, which could also affect their ability to manage new credits. The reputation of credit institutions could also be damaged in so far as they provide financing to companies whose activity is most harmful to the environment.

33 And it would also entail a higher credit risk if these assets were used as collateral for loans. Note that, while market risk refers to the sudden loss of value of assets, climate risks could also revalue assets issued by certain companies; for example, an increase in the price of CO₂ (transition risk) could benefit renewable energy companies.

are also studies that conclude that investors are not yet discounting climate risks in asset prices. For example, Murfin and Spiegel (2020) find no effect of sea level rise risk on property valuations in coastal areas.

As regards equities, as mentioned in section 2, there is empirical evidence that the stocks of the most polluting companies offer higher returns to investors in compensation for the transition risk they are assuming (Bolton and Kacperczyk, 2021, and Alessi et al., 2021), although other works find the opposite⁽³⁴⁾ (Pastor et al. 2021b). For their part, Hong et al. (2019) find that the stocks of food companies in a wide range of countries are not efficiently pricing the physical risk derived from droughts. And the International Monetary Fund itself in its April 2020 Financial Stability Report notes that, in general, there is little evidence that the equity market is incorporating premiums associated with physical risk (IMF, 2020).

Focusing on “stranded assets”, in which transition risk is particularly obvious, Batten et al. (2016) find through an

event study that, although a negative effect was observed on the abnormal returns of oil and gas companies in France, Germany, the United Kingdom and the United States after the signing of the Paris agreements, this effect was not statistically significant (in contrast to renewable energy companies where the effect was positive and significant).

In summary, there is no conclusive evidence that markets, particularly equity markets, are efficiently incorporating climate risks (Venturini, 2022). Indeed, Stroebel and Wurgler (2021), in a survey of nearly 1,000 people among finance academics, market practitioners, regulators, etc., obtained as a majority response that asset prices do not sufficiently reflect, for the time being, such risks. In addition, the invasion of Ukraine in February 2022 and the consequent need to secure energy supplies may have put the incorporation of climate risk into the valuation of assets, in particular in the valuation of “stranded assets”, on the back burner.

Liquidity risk

Banks’ liquidity risk could be affected if climate change impacts their ability to raise funds and repay their debt as it matures and/or if there are changes in their customers’ demand for liquidity. Very few studies have analysed the effects of climate change on banks’ liquidity risk, and those that do exist have focused almost exclusively on physical risk, in particular the impact of natural catastrophes (BIS, 2021b). For example, Brei et al. (2019) observe deposit withdrawals by households and firms to finance hurricane disaster recovery in the Caribbean. There would also be a liquidity risk if credit institutions were to experience difficulties in placing their brown bond issues in the event of a change in investor preferences that would lead them to demand more green assets. Moreover, in such a context, the conventional bonds that banks would hold in their portfolio would be less liquid as they would be more difficult to sell (Álvarez et al., 2020). In this case, liquidity risk would probably also lead to market risk. And in turn, banks whose balance sheets are more exposed to credit and market risks may have difficulty financing themselves

in the short term, thus favouring greater liquidity risk (Bolton et al., 2020).

It is important to note at this point that, although it is more immediate to relate banks to financial stability problems arising from climate risks, it is not less true that other financial institutions such as insurers, investment funds or pension funds could also be affected by them. In this regard, a joint study by the ECB and the European Systemic Risk Board (see ECB, 2021) that seeks to quantify the exposure of banks, investment funds and insurers to climate risks reveals that the market risk for investment funds could be quite high, since in most EU funds the companies that represent the largest percentage of their portfolios are precisely the most polluting. In the case of insurers, this market risk does not seem negligible either, since in addition to their holdings of shares and bonds of companies with a higher rate of emissions, there is also indirect exposure through their investments in funds which, as we have just pointed out, are also exposed to this risk.

³⁴ As explained in the section dedicated to investors, the high demand for these assets as a result of investors’ increased environmental awareness could be behind this result.

Risk management models for climate-related risks

In 2007, shortly before the financial crisis broke out, Nassim Taleb published his famous idea of a “black swan” to refer to those highly improbable events with global effects and that can only be explained once they have already happened (Taleb, 2007). “Black swan” events are characterised by the fact that they do not follow a normal probability distribution, but a distribution with a higher skewness; thus, while in the normal distribution the probability of extreme events occurring is low, in distributions characterised by a higher skewness these atypical events are more likely. These characteristics of “black swan” events mean that they cannot be predicted either from past data or with traditional risk models that assume normal probability distributions, such as Value at Risk (VaR) models⁽³⁵⁾.

Building on the concept coined by Taleb (2007), Bolton et al. (2020) call potential financial crises arising from climate risks that could be systemic in nature a “green swan”. Physical and transitional risks could generate extreme events that would be difficult to predict using past data, hence the idea of a “green swan” related to that of a “black swan”⁽³⁶⁾. Consequently, the traditional VaR approach to risk management would not be suitable for assessing future financial losses that might occur as a result of weather-related risks (Kunreuther et al., 2012), nor for estimating the probability of such losses taking place, since, as noted above, normal distributions underestimate the probability of extreme events occurring and therefore underestimate the magnitude of the risk.

It would be necessary to use forward-looking methodologies (Battiston, 2019), since it would be difficult to extrapolate historical trends to assess the effect of climate risks in the future, for two reasons: on the one hand, because such risks may not be linear (for example, physical risks may become more pressing if temperatures rise above a certain threshold) and, on the other hand, because their materialisation is full of uncertainty, depending on the policies implemented to mitigate climate change, the advance of clean technology or the degree of change in consumer and investor preferences (Bolton et al., 2020).

In this sense, methodologies based on possible future scenarios have been proposed to allow central banks and supervisors to assess the vulnerability of financial institutions to climate change⁽³⁷⁾. The scenarios commonly contemplated are (NGFS, 2020): (i) the orderly scenario, in which measures to reduce emissions and help firms and households to progressively adapt to them are implemented immediately with a view to meeting the Paris Agreement targets by 2050, (ii) the disorderly scenario, in which measures are implemented late and abruptly, and (iii) the “hot house world”, in which the Agreement is breached, the behaviour of firms and households does not change and emissions continue to increase. These three scenarios entail, respectively, that the price of CO₂ emissions increases gradually, that it does so abruptly (and the transition risk soars) or that it does not change. Climate stress tests are based on this methodological approach that uses possible future scenarios. Thus, like the stress tests that aim to assess the resilience of financial institutions to adverse macro-financial scenarios, and whose implementation has become widespread in the wake of the financial crisis, climate stress tests seek to assess this resilience to the possible future scenarios arising from climate change to which we have just referred (De Guindos, 2021).

The ECB’s climate stress test in 2021 on the total economy allowed a number of conclusions to be drawn. On the one hand, the option that would pose the least risk to financial stability is the orderly transition scenario, since in this case the probability of corporate default would be considerably lower than in the other two scenarios. This is due to the fact that, while this probability would initially increase because adaptation to cleaner technologies would increase the production costs of the companies (and thus the credit risk of banks if they have them in their loan portfolio, and the market risk of banks, investment funds, etc. if they have them in their asset portfolio), this cost increase would be offset in the future by the greater energy efficiency that these technologies would lead to. To this should be added the increased costs derived from the increased exposure to physical risks that would result from not adopting the measures assumed by the orderly transition scenario. On

35 For an explanation of the Value at Risk concept and methodology, see for example [Linsmeier](#) and [Pearson](#) (2000).

36 However, there are also differences between the two ideas. In particular, although the future effects of climate change have a high degree of uncertainty, there is some certainty that they will materialise (Bolton et al., 2020).

37 See Bolton et al. (2020) for a more comprehensive review of these methodologies.



the other hand, this test showed, as might be expected, that the effect of climate risks on companies is not uniform, but depends on the geographical area in which they are located and the sector to which they belong.

In 2022, the ECB conducted a new climate stress test involving 104 significant credit institutions to assess their exposure to climate risk and how they manage it. From the results obtained, published in aggregate in July, it is worth noting that 60% of banks do not yet include climate risk in their risk management framework and that only 20% take climate risk into account when granting loans, hence the credit risk they incur is not negligible (ECB, 2022).

Of course, the ECB is not the only one to have implemented this type of tests. They have also been carried out, among others, by the Bank of England, and other central banks, such as those of Canada, Japan and China, have them on their agenda. In addition, international organisations such as the International Monetary Fund and the Bank for International Settlements have clearly expressed their support for the widespread use of these practices.

At this point we may ask whether, unlike the VaR models mentioned, these scenario-based methodologies are free of limitations. The answer is no. The non-linearities that can arise in the materialisation of climate risks and the complex relationships between the different aspects involved (environmental, regulatory, technological, financial to channel resources towards a low-emission economy, etc.) represent an important source of uncertainty, which would require the development of more complex economic models on which there is no academic consensus (Mercuri et al., 2019). Added to this is the need for granular data, that is, much more disaggregated data, to try to quantify,

for example, the probability of default of a given company in the face of adverse weather events, depending on its geographical location or its specific activity within a given industry.

Therefore, while the usefulness of scenario-based approaches is not questioned, for the time being they seem to be aimed at enabling financial institutions to identify their vulnerabilities and thus better integrate climate risks into their risk management framework, rather than at allowing the results to be used by central banks and supervisors to make decisions on prudential matters. In this regard, the ECB has communicated that the climate risk self-assessment test carried out by credit institutions in 2022, which we have already mentioned, is not expected to have direct consequences on their capital requirements⁽³⁸⁾.

To sum up, the difficulties in measuring climate risks and the uncertainty about their degree of materialisation pose a major challenge for financial stability supervisors. The action by these supervisors, in particular central banks, is key to getting banks to incorporate climate risks into their financial risk management to a greater extent than they have done so far.

The extent to which banking institutions (and other economic agents) incorporate climate risk into their decision-making will depend to a large extent on the information that companies provide on their carbon emissions and their plans to reduce them. Central banks could create incentives for companies to provide more transparent information in this regard and also to reduce their emissions. An example is the case of the ECB which, without neglecting that its priority objective is price stability, since October 2022 has been applying a “portfolio tilting”

38 The European Banking Authority (EBA) has recently opened a debate on whether climate risks should be taken into account in the prudential framework for credit institutions and investment firms (EBA, 2022).

strategy in the reinvestment of the nominal values of the bonds it has acquired under the Corporate Sector Purchase Programme (CSPP), increasing the weight of companies that obtain the best score in terms of their polluting emissions, their reduction targets and the quality of the information they disclose in this regard⁽³⁹⁾. Its intention to consider climate criteria from 2024 onwards

in the assets provided as collateral by banks when applying for Eurosystem financing, and to accept in the future for this purpose only assets issued by companies that comply with the European Commission's Corporate Sustainability Reporting Directive, is another example of the ECB's contribution to achieving the EU's climate neutrality goals and the Paris Agreement.⁽⁴⁰⁾

6. By way of conclusion

Throughout these pages, we have highlighted some of the main issues addressed in the academic literature (theoretical and empirical) as a consequence of the incorporation of the sustainability factor into the study of Finance. Without intending to be exhaustive, our aim has been to show how sustainability is challenging some models and definitions in the field of asset valuation and corporate valuation and governance, also expanding the challenges in regulatory and supervisory matters.

With regard to regulation, although the private initiative took the lead over the public one, it is currently the latter (through mandatory or voluntary regulations) that is making most progress (especially in the EU) with various objectives, such as homogenising the criteria defining sustainable financial products (what is a green financial product), increasing the information requirements that companies have to provide regarding their sustainable behaviour (Non-Financial Information Statement) or encouraging greater involvement of certain investors in sustainability (Codes of Good Practice for Institutional Investors). All of which adds up to the already existing conglomerate of private standards and signalling mechanisms (such as rating agencies), helping to improve the information provided to investors and, consequently, allowing more resources to be better mobilised to finance sustainable development. However, we draw attention to the consequences of over-regulation, which in the case of the EU has been called the "regulatory tsunami", such as the "crowding out" of smaller companies from the securities markets.

With regard to supervision, while climate change can trigger financial risks affecting firms, households, countries and, in general, the entire economy, maintaining financial stability requires in particular that credit institutions are able to adequately manage these risks. The supervisors of these entities, in particular central banks, are increasingly involved in this task, given the possible systemic nature of the risks associated with climate change. Evidence to date on the extent to which banks are integrating climate risks into their risk management framework indicates that, while progress has been made in recent years, much remains to be done and supervisory efforts in this regard still have a long way to go.

It has also been highlighted the importance of considering a change in citizens' preferences, whether as investors, producers or consumers, whose consistency will have to be assessed in the future, since the persistence of this change is essential for the financial or firms models that assume it as a starting point to achieve the results they expect. Focusing on their role as investors, the inclusion of sustainability as a desirable feature of the financial products they include in their portfolios appears to be already playing an essential role that will need to be taken into consideration by potential borrowers.

In any case, as can be seen throughout this work, the academic literature, both theoretical and empirical, is in full bloom, as shown by the fact that most of the references used in this paper are very recent. Therefore, the state of

39 See <https://www.ecb.europa.eu/press/pr/date/2022/html/ecb.pr220919-fae53c59bd.en.html>. With this "portfolio tilting", the ECB is also reducing the financial risk to its balance sheet associated with climate change. The net purchases under this Programme, which began in 2016, ended in July 2022 and since then only the nominal values of previously acquired securities that are maturing are reinvested, although from March 2023 onwards the volume of such reinvestments will start to decrease. It is important to note that the volume of corporate bond purchased has been and continues to be driven exclusively by monetary policy considerations.

40 See <https://www.ecb.europa.eu/press/blog/date/2022/html/ecb.blog220708-1c7076c7b1.en.html>.

the matter that we show here is based on a literature that is in the process of development, thus the results presented

here should be taken with some caution, as there is much room for future contributions.

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