

THE RISK OF CLIMATE CHANGE FOR FINANCIAL MARKETS AND INSTITUTIONS:
CHALLENGES, MEASURES ADOPTED AND INTERNATIONAL INITIATIVES

José Manuel Marqués Sevillano and Luna Romo González (*)

(*) José Manuel Marqués is Head of the Financial Innovation Division of the Associate Directorate General Financial Innovation and Market Infrastructures. Luna Romo González is an economist in the International Financial Markets Division.

The authors thank Ricardo Gimeno and the anonymous reviewers for their useful comments.

This article is the exclusive responsibility of the authors and does not necessarily reflect the opinion of the Banco de España or the Eurosystem.

THE RISK OF CLIMATE CHANGE FOR FINANCIAL MARKETS AND INSTITUTIONS: CHALLENGES, MEASURES ADOPTED AND INTERNATIONAL INITIATIVES

Abstract

The 2015 Paris Agreement acknowledged the need to mobilise financial flows towards investments supportive of a low-greenhouse-gas-emissions economy and that are environmentally beneficial, what is known as “green finance”. The article explains the debate on the new demands climate change places on the financial system as a whole and on the banking system in particular, so that they may join the fight to minimise damages and support preventive initiatives. An analysis is made of the extent to which the financial markets and banks acknowledge and act in consequence of the risks to which climate change exposes them. The main national and international measures geared to improving the perception of climate risk and to helping financial markets and intermediaries identify green projects are also reviewed. The authors conclude that climate change has not been fully taken on board by the financial sector and they identify several obstacles preventing the mobilisation of funds for green projects, although the overall assessment at the international level reveals favourable developments in this respect.

1 Introduction

Combating climate change is one of the most pressing issues on the political agenda of countries and international organisations. After several international conferences on climate change sponsored by the United Nations, the Paris conference of 2015 set clear objectives shared by virtually all nations to prevent a global temperature rise and to ensure sustainable economic development. The Paris Agreement sets out a number of specific goals in Article 2, including: to prevent the Earth’s temperature from rising by more than 2°C compared with pre-industrial levels; to increase the economy’s adaptability to the adverse impacts of climate change; to foster development with low greenhouse gas emissions; and to encourage financing for the investments required to support sustainable economic growth.

Compliance with these objectives is instrumented through different national plans (the so-called *National Development Goals* or NDGs), which have common elements and principles but must be adapted to the specific circumstances of each country depending on, for example, its sources of energy or its level of development. The degree of compliance with these plans shall be reviewed periodically. These plans comprise different measures and instruments which include establishing a price for carbon dioxide emissions, incentives to develop or improve renewable energy production, the development of carbon sinks, promoting civic education to encourage energy saving or redesigning mobility in cities.

To achieve these goals, it is essential for funds to be mobilised to support the necessary investments. Therefore, the financial sector will have to play a crucial role. In fact, the Paris Agreement explicitly mentions financial flows in its articles. The financial sector’s role not only relates to its capacity to channel and act as intermediary for the financial resources required to transform the productive structure of the economy, but also involves identifying and assessing risks, which is of utmost importance when creating incentives for the various agents to adopt investment and production decisions that are in keeping with the environmental objectives agreed on by virtually all nations.

In this regard, it is not surprising that while public authorities develop their energy transition plans, the financial community is beginning to pay closer attention to the creation of instruments aimed at investments that are compatible with a sustainable economy. There is also an increasing interest in the ways in which the economic risks brought by climate

change can be measured and identified. It is important to note that these risks entail not only the financial damage associated with natural disasters related to climate change (known as physical risk), but also the costs that certain companies may incur under tougher environmental legislation which, for example, penalises the carbon footprint of production, known as transition risk (see section 2.1).

The banking sector is also affected by this trend, in a number of different areas. First, after the great financial crisis, the banking sector has showed higher concern for risks related to corporate social responsibility, among them environmental risks. Therefore, as has occurred in other sectors, it has started to focus on instruments for investments that are compatible with a more sustainable economy. It is also becoming more concerned about measuring and identifying the exposure of its assets to climate-change related risks. Lastly, as in other sectors, banks must review the information they publish periodically, so that investors and analysts can assess each institution's progress in mitigating these risks.

This article aims to review the main changes taking place in the financial sector as a result of the transition towards a more sustainable economy, and the main initiatives being discussed in the private and public sectors, at national and international level, focusing particularly on Europe. Thus, in section 2, the different climate change risk categories are defined, paying particular attention to the transition or carbon risk. The article goes on to address the question of whether the markets, investors, and especially the banks are factoring in climate risks in their financing and investment decisions. How investors value these "green" instruments and how they compare with similar instruments not classified as such can give us an idea of their sensitivity to environmental risks. Section 3 examines the obstacles to the internalisation of climate change risks and the full development of green financing. It also considers some of the initiatives in the private and public sectors at the national level to tackle these obstacles. Section 4 reviews international initiatives to coordinate the financial sector's response to climate change and the efforts to overcome the difficulties in achieving the decarbonisation of economies and complying with the Paris Agreement. Lastly, some conclusions are drawn in Section 5.

2 Is the financial system taking climate change risks into account?

2.1 CLIMATE-CHANGE RISKS: CONCEPT, FACTORS AND MEASURES

Analysts usually assess environmental risk along with other factors, such as social and governance aspects, commonly known as ESG (Environmental, Social and Governance). However, the risk relating to climate change merits a separate analysis, since it has distinct characteristics that make it difficult to justify the joint consideration of different concepts from a methodological standpoint. The consideration of environmental risks by social and economic agents is a long-established fact, at least in parts of the financial sector. We refer specifically, to aspects such as industrial accidents that have a harmful impact on the environment (for example, an oil spill) or natural disasters for which insurance and reinsurance firms have been offering financial coverage for some time.¹ This article shall focus in particular on risks associated with climate change and global warming, phenomena to which attention has turned more recently (2DII, 2015a).

Risks associated with climate change are classified into two broad categories: physical risks, which arise as a result of climate-related or geological events or changes affecting the equilibrium of ecosystems (G20, GFSG, 2016), and transition risks, which relate to the transition to a low-carbon economy as a response to climate change. Physical risks may

¹ These risks can be transferred to other agents by means of catastrophe bonds, which have existed since the mid-1990s and are usually issued by reinsurance companies (also by other sectors) and bought by investors facing losses as a result of a natural disaster. See Edesses (2015).

arise gradually (e.g. rising sea levels, desertification) or abruptly (e.g. storms, droughts) and always entail physical damage to companies' assets, supply chain disruptions or an increase in the costs required to address such events (WRI and UNEP-FI, 2015 and TCFD, 2017a).² Transition risks, also known as carbon footprint, are associated with the policy priorities set by each country to combat climate change, in which the reduction of greenhouse gas emissions normally plays a key role.³ These policies could end up affecting companies, either by having an impact on their economic activities or on the assets in which they have invested. These concepts are not unrelated; the more decisive the measures to combat climate change or, in other words, the higher the transition risk, the lower the future physical risks and vice versa (Finansinspektionen, 2016; Federal Ministry of Finance, 2016).

Carbon or transition risk, which is probably one of the most analysed aspects of climate change, encompasses several factors or sub-categories (see WRI y UNEP-FI, 2015):

- The political factor, which refers to the impact of regulatory and legislative changes (e.g. the Paris Agreement, at international level, but also at national and local levels), either to limit the actions that contribute to damaging the environment and speeding up climate change, or to increase the ability to adapt to the adverse effects of climate change (TCFD, 2017a). This includes, for example, setting direct and indirect limits or taxes on greenhouse gas emissions, the creation of carbon pricing systems (e.g. the EU's Emissions Trading System), anti-pollution standards or standards to foster the development of low-carbon technologies, etc.
- The legal factor referring to the legal proceedings that companies may face if they fail to comply with environmental legislation, for example.
- The technological factor, relating to the development of low-carbon or energy-efficient technologies (e.g. rapidly decreasing solar energy prices in recent years).⁴
- Market and economic factors, which include the impact on the operational and financial viability of assets of changes in market conditions and in the economy, such as changes in oil and coal prices and demand.
- Reputational and social factors, less clear-cut and more difficult to measure, arising from a company's image being linked to the use and promotion of assets involving high carbon emission levels. This includes, for example, the impact of campaigns to promote divestment in fossil fuel companies.

Financial institutions, in particular, face what may be considered an additional regulatory risk, consisting of changes made to financial regulations to address climate change which

2 A third type of risk, known as *liability risk*, could also be considered separately (Carney, 2015 and Volz, 2017). This risk could arise if compensation is sought by those suffering losses related to climate change or environmental damage, and could have a major impact on some sectors, such as insurance firms.

3 WRI and UNEP-FI and 2DII associate carbon risk with non-physical climate change risk (UNEP-FI, 2015 and 2DII, 2015a). Görden *et al.* (2017) relate the carbon risk factor with a company or asset's value as a result of the transition to an economy towards a low-carbon economy. This article therefore uses carbon risk as a synonym for transition risk.

4 For example, between 2007 and 2014, the price of photovoltaic solar panels fell by 80% (see World Economy Council, 2017).

may require them to change their policies regarding investment in carbon-intensive assets or strengthen their management and transparency with regard to their exposure to climate change risks.

Measuring carbon risk is not straightforward but can be approximated in a number of different ways. The most popular approximation is known as the “carbon footprint”, which refers to a company’s level of greenhouse gas emissions over a period of time.⁵ A more comprehensive quantification of this risk, as suggested by Hoffman and Busch (2008), could take into account the carbon (or fossil fuel) input in a company’s production process (for example, plastic materials, even though they are not sources of emissions), and the carbon output, creating the concept of “carbon usage”. There are also alternative indicators, such as “carbon intensity”, which is the ratio between a company’s “carbon usage” for a defined period of time and the sales or profit levels.⁶ These measures not only apply to specific companies, but may be used in other areas. Thus, in MSCI (2015), it is explained how these indicators may be used with investment portfolios, using the “carbon intensity” and the “weighted average carbon intensity” ratios as proxies for the efficiency and exposure of a portfolio to carbon-intensive companies, respectively.

Another way of approximating carbon risk is to identify the emissions linked to the fossil fuel reserves that cannot be burnt according to the objectives of the Paris Agreement⁷ (CTI, 2011). Using this approach, risk analysis consists of identifying sectors and companies that own these reserves (and the assets linked to these reserves), which could suffer substantial revaluations before the end of their useful life. In other words, these reserves could be “stranded” in the transition to a low-carbon economy.⁸

In the case of physical risks of climate change, other methods that take into account, for instance, the geographical location of companies, their assets and their sensitivity to climate-related events, need to be used, depending on their specific characteristics (see, for example, Deutsche Asset Management and Global Research Institute, 2017 and DNB, 2017).

2.2 ARE THE MARKETS TAKING CLIMATE CHANGE RISKS INTO ACCOUNT?

The inclusion of climate change risk and of carbon risk, in particular, in the price of financial instruments, is essential for mobilising the resources necessary to support the transition to an economy with low greenhouse gas emissions. One of the first studies to try to determine whether or not such support exists was conducted by the Carbon Tracker Initiative (CTI), which introduced the concept of the “carbon bubble” in 2011 (CTI, 2011) and concluded that the markets were still far from putting a price on carbon risk. This study (and its 2013 update, see CTI 2013) considers what it believes to be an incorrect valuation of fossil fuel reserves by the financial markets as a market failure, for the following reasons: 1) approximately 65-80% of the reserves of publicly listed gas, coal and oil companies are not burnable

5 In spite of the progress in the measurement of the carbon footprint, there can be other factors that determine the exposition to carbon risk of a company or a portfolio [MSCI (2015)]. For instance, a study of 2DII (2015b) concluded that there is almost no correlation between the carbon intensity measure of a company and the value of carbon risk of that specific company according to several analysts. Therefore, it is important to take into account other factors and not oversimplify this risk in just one measure.

6 FIR (2016) from a more positive angle, proposes measuring “avoided emissions”.

7 The Intergovernmental Panel on Climate Change (IPCC) estimates that, at the current pace, fossil fuel reserves that could be burnt to meet climate change objectives, will have run out completely by 2045 (IPCC, 2017), which means that most of the fossil fuel reserves that currently exist are unburnable (IPCC, 2014). However, the current valuation of many fossil fuel companies depends largely on these reserves.

8 Assets such as drilling platforms and distribution infrastructures could become unusable, with negative repercussions for other industries such as electricity production, heavy industry, agriculture, transport and real estate (NDB, 2016).

in a 2°C scenario, which is a clear example of the fossil fuel sector’s specific transition risk (see BOE, 2017); 2) large amounts of capital are still being spent on exploiting new reserves, despite the fact that current reserves already exceed the carbon budget (this is known as “wasted capital”) and 3) the New York and London stock markets have a very high absolute exposure to fossil fuel reserves (CTI, 2013).⁹ Therefore, the authors conclude that a significant adjustment to the price of shares of fossil fuel-based companies can be expected in the near future, with all the consequences that this may entail for their investors.

However, subsequent academic studies provide some evidence of the fact that markets are beginning to take carbon risk into account. For example, Griffin *et al.* (2015) show that the shares of gas and oil companies in the United States reacted adversely (with a 1.5%-2% drop) to the publication in 2009 of two articles in the journal *Nature*¹⁰ which warned that only a fraction of fossil fuel reserves are burnable if the rise in temperature is to be limited to 2°C by 2050. However, although statistically significant, this adverse reaction seems negligible in economic terms.¹¹ Jung *et al.* (2014) have found that, in the case of a group of Australian companies, those with higher carbon-related risk exposure face a higher cost of debt and can mitigate this penalty by providing evidence regarding their sensitivity to environmental issues. Görgen *et al.* (2017) have explained the way in which the capital markets quantify carbon risk, using datasets relating to greenhouse gas emissions and to the environmental agenda, and have found that companies considered to be “brown” (that is, with a higher exposure to carbon risk) perform worse on the stock exchange, compared with those that are “greener”. This relationship is significant in econometric terms and becomes more patent from 2012 on, coinciding with the improved economic outlook and the creation of the concept of carbon bubble and stranded assets.

Thus, the most recent evidence indicates that there is growing sensitivity to carbon risks. A sign of the increased sensitivity to climate risks is the rapid growth seen in the issuance of the so-called “green bonds”,¹² that is, bonds whose proceeds are intended to finance or refinance assets relating to climate change mitigation and adaptation, and other projects with a positive environmental impact.¹³ The first green bond was issued by the European Investment Bank in July 2007. The immediately following years were characterised by low volumes of issues and by the central role of supranational institutions and public agencies. At the end of 2013, the first green bonds were issued by the corporate sector (by Bank of America Merrill Lynch-BofAML and Electricité de France) and, coinciding with the publication of the Green Bond Principles in 2014, which defined standards for the issuance of this type of instrument, the market practically tripled the volume issued in all preceding years, and as many as 11 countries launched them for the first time. In 2017, green bond issuance hit a record high, at almost USD 119 billion (+ 49% y-o-y).¹⁴ The diversity of

9 Moreover, these companies are major issuers on the bond market (see Section 2.3).

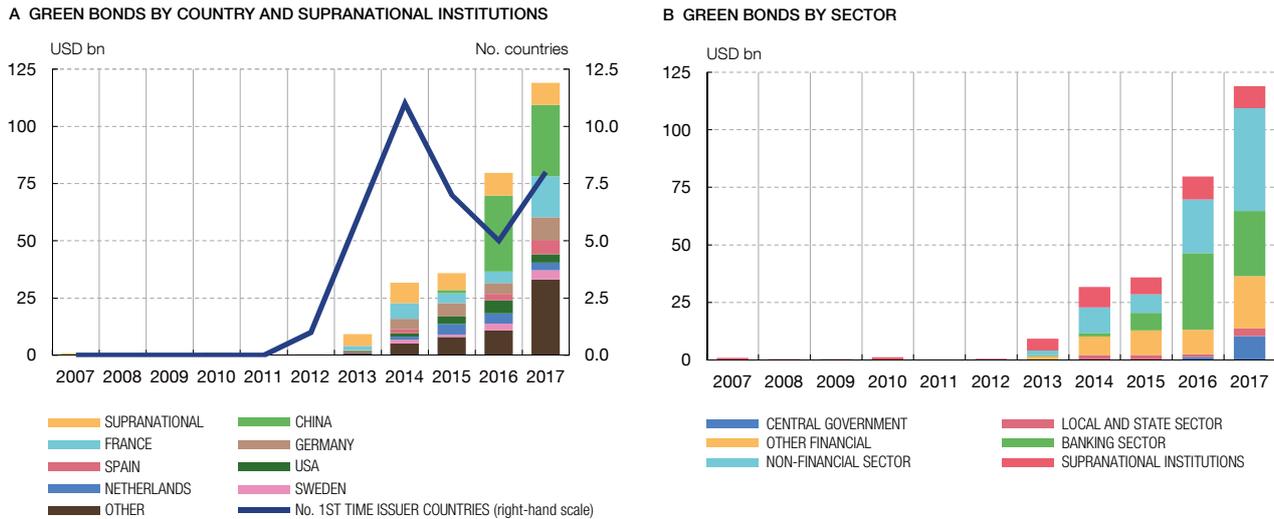
10 Allen *et al.* (2009) and Meinshausen *et al.* (2009).

11 This would not necessarily be indicative of a carbon bubble, according to the authors, insofar as investors are valuing other elements, such as carbon capture technologies or the relative lack of elasticity of demand for fossil fuels in the future.

12 The green bonds is the most successful “green finance” instrument to date, but not the only one. Green finance is understood to be finance for investments that expressly yield previously defined environmental benefits, within the broader context of sustainable finance, which is characterised by having social, economic, governance and environmental goals (HLEG, 2017).

13 For example, green bonds can finance energy efficiency, diversity conservation or sustainable transport projects, among others (ICMA, 2017a and HLEG, 2017).

14 According to the CBI (2018), bond issuance in 2017 reached USD 155.5 billion. The data used in this article refer to bonds identified by Dealogic as green bonds in accordance with the ICMA principles, excluding short-term bonds, securitisation bonds and sustainable bonds, which devote their proceeds to both green and social projects. There are other more comprehensive lists of green bonds, such as that of the CBI itself. Finally, these



SOURCE: Banco de España, based on Dealogic data.

a Does not include securitisations, short-term debt or sustainable bonds (the proceeds of which go to financing green and social projects).

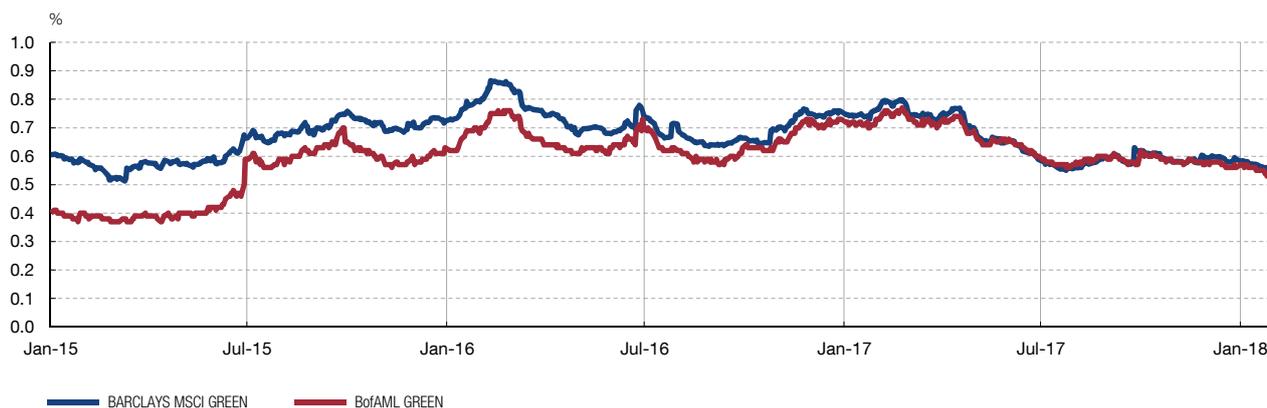
issuers has also increased notably, both in terms of country and sector, and of type of instrument (e.g. Covered bonds and green securitisations). Currently, the main issuer countries are China, France, Germany and the United States (see Chart 1a). The main issuer is the non-financial sector, followed by the financial sector and supranational agencies (see Chart 1b).

Secondary fixed-income markets can also provide information about how investors are valuing climate risks. Since 2014, considerable progress has been made in creating green bond indices (for example, Solactive, S&P, BofAML and MSCI/Barclays), which points to an increase in the diversity of issuers and to investors' need for a benchmark to value this type of product. These indices establish criteria for inclusion which allow for a degree of homogeneity in matters such as liquidity or compliance with the green bond principles (ICMA, 2017b and Bloomberg, 2017). Chart 2 shows the yield spreads on the Treasury securities of two green indices. As can be observed, the yield spreads of the two indices become narrower and disappear altogether at the end of the period. The spreads are affected by the change in the composition of the indices and by uncertainties in the markets (for example, tensions relating to bank debt at the beginning of 2016, the United Kingdom's decision to leave the EU in the summer of that year or the US elections at the end of 2016). In 2017, the yield spreads continued to fall to levels not experienced since 2015, and the trend persisted in early 2018. Therefore, although green bond issues increased in 2017, demand remained robust.

To have an idea of their relative performance, it is important to compare these indices with other, broader, indices whose composition includes bonds of companies with a high exposure to climate risk.¹⁵ Panels A and B of Chart 3 show the total hedged returns in

data do not take into account the bonds of *pure-play* companies, that is, companies that are mostly linked to green projects and issue green bonds for which there is no formal certification.

¹⁵ It is implicitly assumed that the weight of green bonds in the aggregate indices is limited enough not to constitute a determining factor.



SOURCE: Barclays and BofAML.

a The option-adjusted spread (OAS) is the spread between a bond yield and the Treasury security yield in the same currency, adjusted when a bond has call and put options. There may be some differences in the calculation of the OAS of Barclays and BofAML.

euros of two green indices, since the beginning of 2017, compared with indices with a broad coverage. In the period reviewed, it is clear that green bonds have slightly higher returns than the broad indices. Panels C and D show that, over a longer period, the yields of the green indices are generally lower than those of the broad indices, which suggest that green bonds have a negative premium in the secondary market. This may be indicative of the internalisation of climate risk. However, it is worth bearing in mind that comparisons between the green and the broad indices are flawed, to say the least. In the case of the BofAML indices, there are major differences regarding duration, currency (the dollar prevails in the broad index), the weight of sovereign issues (greater in the broader index) or the type of instrument (the green index does not include securitisations). In addition, the green indices have a very high concentration of certain sectors, such as utilities. This lack of comparability may delay the inclusion of these indices in the mandates of institutional investors, since it makes it difficult to determine how markets are actually valuing climate risk.

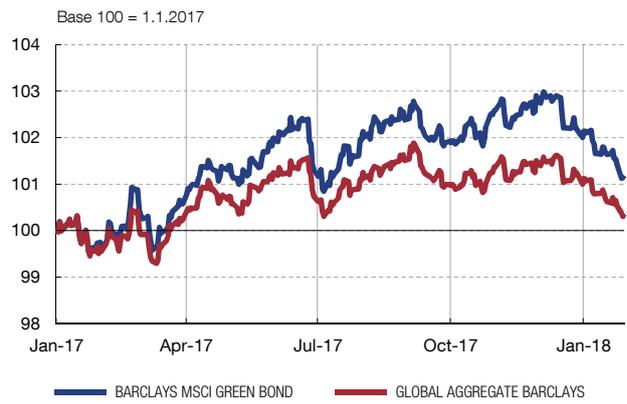
To avoid the problems of comparability between indices, some authors have opted to compare specific bonds classified as green with other, similar bonds from the same issuer, but not classed as such. Zerbib (2017) makes this comparison, controlling for aspects such as maturity, currency, credit rating, etc., and concludes that green bonds would have a negative premium compared with bonds that are not green, particularly in the case of dollar and euro-denominated bonds. Barclays (2015) and the BIS (2017) have reached similar conclusions using different methodologies. However, in view of the still limited size of this market, in relative terms, it is too early to rule out that other factors, such as supply shortages, may be conditioning these results.

Lastly, it should be noted that the specific format of bonds may also influence the yield spread. Thus, in the case of green bonds where the bondholder has recourse to the issuer's assets, the green label does not necessarily reflect the credit risk differences between the green bond and the conventional bond, but, probably, other factors such as investor demand for reputational reasons. In contrast, in the case of bonds linked to project financing, securitisations or covered bonds, a negative spread between instruments classified as green and those that are non-green (for example, between a green covered bond and a brown covered bond of a similar nature) would better reflect the credit risk,

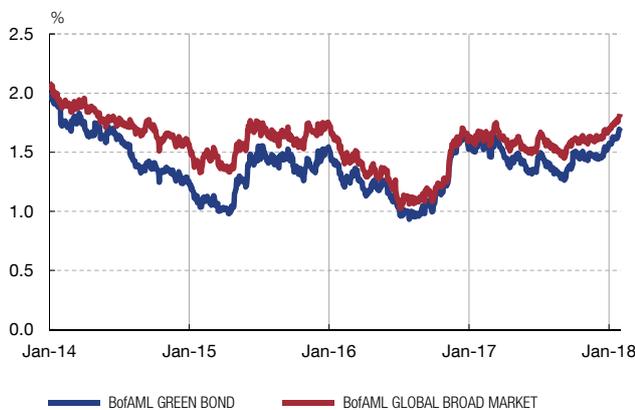
A RETURNS ON GREEN BONDS AND BROAD INDEX (BofAML)



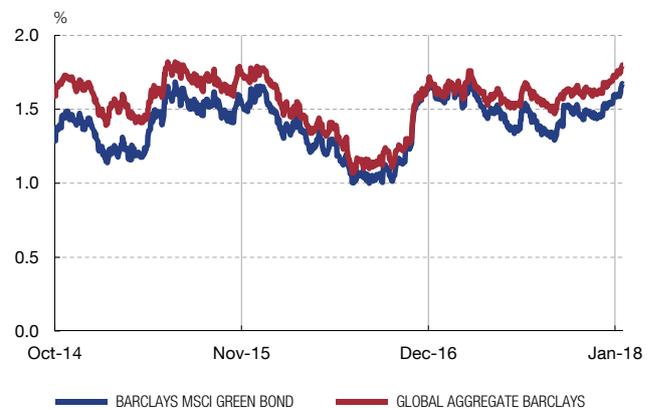
B RETURNS ON GREEN BONDS AND BROAD INDEX (BARCLAYS)



C YIELD TO MATURITY GREEN BONDS AND BROAD INDEX (BofAML)



D YIELD TO WORST GREEN BONDS AND BROAD INDEX (BARCLAYS) (a)



SOURCES: Barclays and BofAML.

a Yield to Worst is defined as the lowest yield that a buyer can expect among several alternatives, including, for example, the possibility of the bond being called.

given the closer correlation between the bond and the collateral backing it in the event of default.

Green indices have also been developed in the equity market. Chart 4 (panel A) compares the global aggregate MSCI index with some low-carbon indices: the “low-carbon target” and “low-carbon leaders” indices and indices “excluding fossil fuels”.¹⁶ The first two indices try to replicate the performance of the broad index, minimising carbon exposure and aiming to serve as a benchmark for investors that wish to manage this risk without departing from general market trends. The MSCI index that excludes fossil fuels indirectly shows the market’s valuation of carbon exposure, as it has a level of profitability that is clearly higher than that of the aggregate index. However, other factors of a more cyclical

¹⁶ The “low-carbon target” and “low-carbon leaders” indices are designed to minimise carbon intensity. While the first index gives a greater weight to companies with low carbon emissions (current and potential), albeit maintaining the full range of companies, the second index excludes companies with a higher emissions intensity and the largest holders of carbon reserves. Both are optimised to achieve a low tracking error relative to the aggregate index. The index which excludes fossil fuels rules out companies on the basis of their fossil fuel reserve holdings, but includes, for example, utilities companies with high emissions. It does not seek to minimise the tracking error and follows a strategy that is easier to understand.

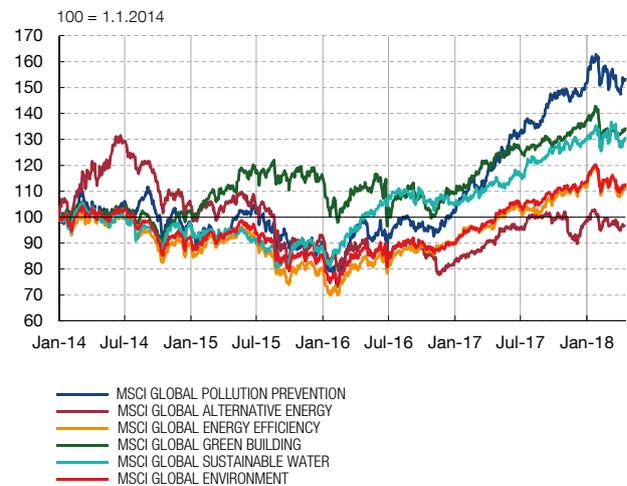
PERFORMANCE OF SHARE PRICE INDICES OF LOW-CARBON COMPANIES WITH RESPECT TO GENERAL PRICE INDICES, AND PERFORMANCE OF SHARE PRICE INDICES OF COMPANIES PRODUCING WITH CLEAN TECHNOLOGIES

CHART 4

A RELATIVE PERFORMANCE OF LOW-CARBON INDICES COMPARED WITH BROAD INDEX (a)



B MSCI ENVIRONMENTAL INDICES



SOURCE: Datastream.

a Panel A shows the performance of each low-carbon index compared with the MSCI AC WORLD.

nature (for example, relating to the oil market) could be driving this trend. Chart 4 (panel B) shows the performance of the indices of companies linked to clean technologies or with a positive environmental impact, and notable differences can be observed in the various categories, which probably reflects the significance of factors other than environmental risks (such as the degree of maturity or possible success of the different technologies).

In short, we can conclude that there is, at present, some evidence that investors and issuers are beginning to take climate risk into account. An example is the emergence of financial instruments that reflect a commitment to contribute to preventing climate change, either in the form of bonds or through the creation of specific indices (both equity and fixed-income) which group together the instruments of companies with a positive environmental impact. As regards the valuation of these products in fixed-income markets, there is evidence suggesting that some green instruments have a lower premium and a higher rate of return. In the equity market, there are signs that the greener indices have higher yields. However, these results must be treated with some caution, since the volume of such instruments is still small relative to the market as a whole, and these conclusions are therefore merely preliminary.

2.3 ARE THE BANKS TAKING CLIMATE CHANGE RISKS INTO ACCOUNT?

Banks play an essential role in mobilising the funds needed to finance a low-carbon economy, both in their capacity as financial intermediaries and through the creation and placing of instruments traded in the financial markets. Banks may be exposed to transition risks through their investments in and financing of carbon-intensive assets (known as “carbon asset risk”, see WRI and UNEP-FI, 2015) and may be affected by the negative consequences on the economy of, for example, an abrupt transition (ESRB, 2016). Banks also face physical climate change risks both directly (operational risk) and indirectly through their portfolios (credit risk and market risk), depending on the location, sectoral diversification and/or insurance of their assets (French Treasury, 2016 and BOE, 2017). From a prudential standpoint, climate risks could have a systemic effect and cause instability in the financial system (Carney 2015 and TCFD, 2017a). Therefore, the question

Study or report	Scope	Conclusion
Weyzig <i>et al.</i> (2014)	EU	Exposure to companies with fossil fuel reserves represents 1.3% of total banking assets at end-2012. Limited risk for financial stability under baseline scenario.
Robins and McDaniels (2016)	G20	Banks' awareness of climate change has increased and this had led to strategic action and risk management.
Battiston <i>et al.</i> (2016)	50 largest listed European banks	The largest European banks have major exposures to some sectors that are vulnerable to climate mitigation policies (for example, the residential sector).
Hierzig (2017)	15 largest listed European banks	Classification of banks according to several parameters. Banks performed worse in the area of carbon risk assessment and management, compared with the more prospective areas, such as climate strategies and governance.
Rainforest Action Network <i>et al.</i> (2018)	37 largest banks in North America, Europe, Japan, China and Australia	Banks continue to provide financial services to sectors with higher risk of stranded assets (<i>extreme fossil fuels</i>). Following an improvement in 2016, banks' support for these activities increased in 2017.
Marlin (2018)	Worldwide	Some banks, such as JP Morgan and UBS, have begun conducting environmental stress tests of their portfolios and have even started to adjust their lending policies accordingly (for example, by reducing financing to the coal industry).
French Treasury (2016)	France	French banks consider that transition risk is more material than physical risk; lack of methodology to assess climate risks.
Finansinspektionen (2016)	Sweden	Climate risks in the Swedish financial sector are lower than those of other EU countries.
DNB (2016)	Netherlands	Exposure to carbon-intensive sectors, broadly-speaking, entails higher risks for the banking sector than only taking into account exposure to fossil fuel companies.
DNB (2017)	Netherlands	The financial sector has considerable exposure to sectors with high CO ₂ emissions. 11% of the banks' portfolio is linked to carbon-intensive sectors, although the risk seems manageable. Risk of losses in the financial sector owing to increased flooding in the Netherlands.

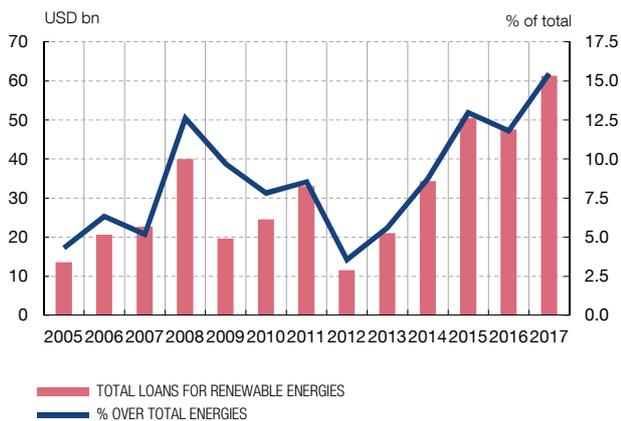
SOURCE: Banco de España.

of whether banks are taking into account climate risks in their asset management and long-term strategies is not only relevant in terms of ensuring the flows needed to finance the decarbonisation of economies, but also to understand the risks for the stability of the financial system as a whole.

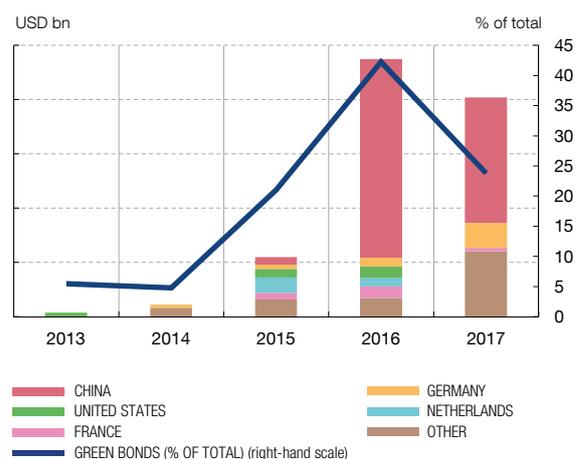
Some studies (mostly on European banks) have concluded that the banking system is beginning to take climate risks into account, although they have found significant shortcomings in the identification, measurement and management of banks' exposure to carbon-intensive assets, which makes it very difficult to make predictions regarding their vulnerability to these risks. Other studies examine developments over time of banks' exposure to assets vulnerable to climate risks and conclude that, broadly speaking, exposures to sectors with a big transition risk are still high (see examples in Table 1).

One way of measuring the action taken by banks to address climate risks is observing their involvement in the opportunities provided by the transition to a low-carbon economy and in raising capital for sustainable projects. In this respect, the volume of syndicated loans intended to finance renewable energies has increased significantly in recent years, in parallel with the development of the related technologies, accounting for more than USD 61 billion in 2017 and more than 15% of total syndicated loans granted to the energy sector

A SYNDICATED LOANS FOR RENEWABLE ENERGIES



B GREEN BONDS ISSUED BY THE BANKING SECTOR, BY COUNTRY



SOURCE: Compiled by authors of this article based on Dealogic data.

a The bonds do not include short-term debt, securitisations or sustainable bonds, that is, those whose proceeds go to green and social projects.

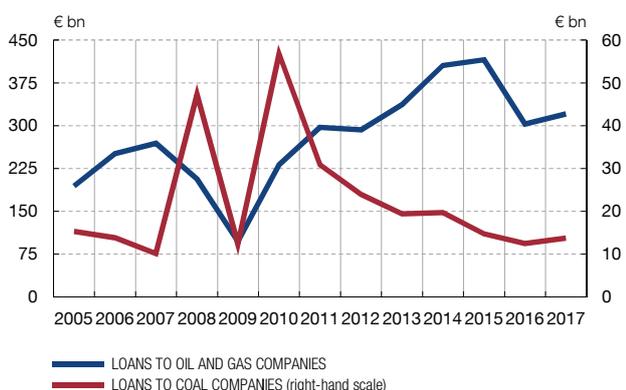
(Chart 5, Panel A). Private banks have substantially increased their presence in the green bond issuance market since the Bank of America issued the corporate sector's first bond in 2013. That year, bank issues represented only 5% of total green bond issuance, but grew to as much as 42% of the market by 2016, currently stabilising at 24%. By country, the banks most active in this type of issuance are in China, Germany, Netherlands and the United States (see Chart 5, Panel B). Moreover, some of these banks have also started to issue other types of instruments such as green securitisations and covered bonds, which have additional advantages to those of normal green bonds (see Section 3.2.1.).

However, these developments are not sufficient in themselves unless progress is made to reduce the exposure of the sectors that are most vulnerable to climate risks. In fact, banks' increased involvement in green finance may still be too closely linked to the consideration of climate risks as part of their corporate social responsibility rather than to the effective management of this type of risk. Chart 6 (Panel A) shows the global volume of syndicated loans to oil, gas and coal companies, understood in a broad sense.¹⁷ Two distinct trends can be observed: on one hand, the volume of syndicated loans to coal companies has declined substantially, in keeping with the lower expected demand for coal in the future and China's transition to clean energies (IEA, 2017) and, on the other, syndicated loans to the gas and oil sector have increased steadily since 2012, with the exception of 2016. Furthermore, these trends are very similar to those of European banks which have also issued green bonds (see Chart 6, Panel B), indirectly suggesting that climate risk does not, as yet, appear to be a determining factor in risk management, even for banks that have issued green bonds.¹⁸ It should also be mentioned that, given the financial disintermediation

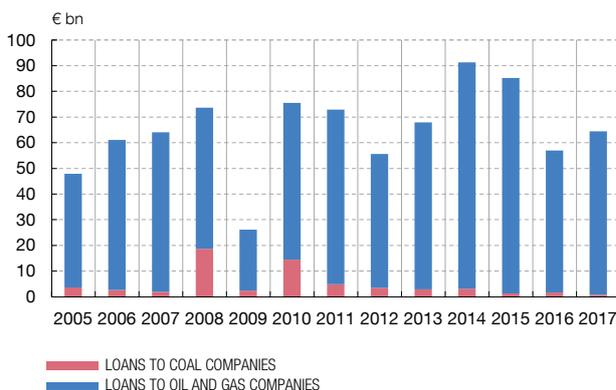
¹⁷ These sectors have high transition risks (WRI-UNEPFI 2015).

¹⁸ This analysis is only an approximation, since our data only take into account syndicated loans and no other type of loans or exposures to these companies, such as shares. Neither does it take into account the changes in the conditions of these loans (maturities, costs, refinancing, etc.) or any new clauses on, for example, the need to comply with emissions reduction objectives to obtain financing (Hierzig, 2017). Finally, we have not taken into account the exposure to other carbon-intensive sectors such as electricity production, heavy industry, transport and agriculture (DNB, 2017).

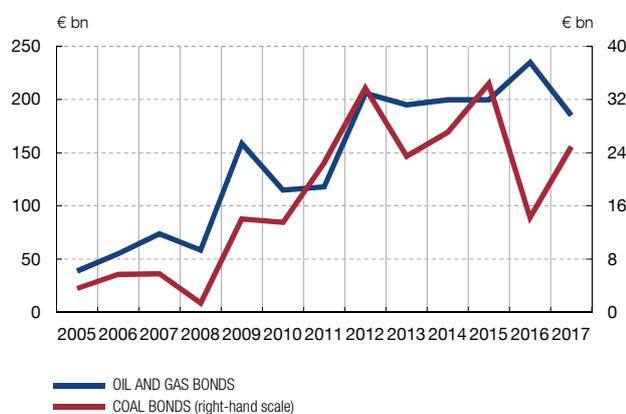
A SYNDICATED LOANS TO COAL, OIL AND GAS COMPANIES



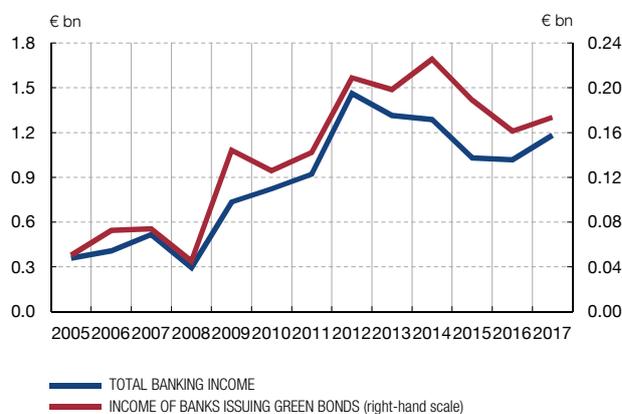
B SYNDICATED LOANS TO COAL, OIL AND GAS COMPANIES FROM EUROPEAN BANKS ISSUING GREEN BONDS



C ISSUES OF COAL, OIL AND GAS COMPANY BONDS



D NET BANKING INCOME FROM PLACEMENT OF COAL, OIL AND GAS BONDS



SOURCE: Compiled by authors of this article based on Dealogic data.

a In Panel B the volume of the syndicated loan is divided equally between the total participants in the syndicated loan. In Panel D, a model to estimate income can be used. In consequence, these two panels may not reflect the actual amount granted or obtained by the bank. A company is considered to form part of the coal, oil or gas industry if the subsidiary that receives the loan is classified as such by Dealogic, according to its NAIC or General Industry Group, respectively. The coal industry includes coal mining and coal wholesalers. The latter may also include other minerals. Oil and gas are defined according to Dealogic and include extraction, manufacturing, transport, refineries and royalties. Bond issuance excludes short-term bonds and securitisations.

process, the profits from the placement of the debt of oil, gas and coal companies is still a major source of income for banks (see Chart 6, Panels C and D).

3 Current obstacles and initiatives

3.1 OBSTACLES

Although significant progress has been made on the development of green finance in recent years and there are signs that both markets and the financial sector are beginning to take climate risks into account, the funds being mobilised are still insufficient to finance the projects necessary for progress towards an economy compatible with the objectives of the Paris Agreement. Thus, in Europe alone, an additional annual investment of almost €180 billion is needed to achieve the 2030 climate and energy objectives (European Commission, 2018). A number of international working groups (such as the groups on green finance set up by the G20) have identified the obstacles preventing full awareness of climate risks.

In economic terms, the main problem is economic agents' failure to internalise the positive externalities of green projects and the negative externalities of brown projects. This results

in under-investment in the former and over-investment in the latter, often amplified, as the G20 report highlights (GSFG, 2016), by the existence of subsidies for the most-polluting sectors. The problems of internalising climate risks partly reflect the fact that they materialise over the long term, while the financial sector (except in the case of certain investors, such as pension funds and insurers) usually concentrates its risk assessments on the shorter term (for example, the shorter time horizons used by asset managers and risk models, see 2DII, 2015a and HLEG, 2017). It is precisely this fact that the Governor of the Bank of England, Mark Carney, termed the “tragedy of the horizon”. The “tragedy” here lies in the fact that when these risks become clearly visible it will be too late to prevent them and so keep global warming below 2°C (Carney, 2015).

Alongside this mismatch in the risk analysis horizon, there are also other reasons for the failure to internalise these externalities. First, in terms of opportunities, there is a lack of labels, standards, or of a uniform and internationally agreed taxonomy of what may be classed as a green financial product or investment. Second, from the standpoint of risks, in particular, there is a serious information asymmetry problem arising from the lack of disclosure, and the lack of instruments with which to analyse the impact of climate risks on the balance sheet and the profits of financial and non-financial companies.

As regards the first obstacle, there is no universally accepted definition at the international level as to what exactly constitutes a green asset or project, as there are no commonly accepted standards, labels or taxonomies.¹⁹ This creates a problem for companies when labelling their assets as green on their balance sheets and makes it difficult for investors to identify and analyse the performance of their green investments. The lack of common definitions also makes it harder to design regulations and public policies to spur investment in green projects (GSFG, 2016, HLEG, 2017) and exacerbates the risk of so-called “greenwashing” (i.e. where an entity takes measures to improve its image of being committed to the fight against climate change without actually reducing its exposure to polluting companies),²⁰ a risk which increases as more participants and industries enter the market and which can damage the issuer’s reputation.²¹

Second, the lack of disclosure of climate information by companies makes it difficult to price and manage climate risks and opportunities. Moreover, the lack of analysis of companies’ climate footprints is also dampening investments in slowing climate change (TCFD, 2017a and OCDE-CDSB, 2015). Thus, disclosure of climate information is essential to the formulation of effective climate policies, setting goals and measuring progress, as is necessary to know the impact of climate risks for financial system stability.

In response to growing demand for climate information, a multitude of national and international standards and initiatives regulating the disclosure of corporate environmental information have arisen. Nevertheless, there are obstacles to the effectiveness of these measures. These obstacles include the lack of common

19 As HLEG (2017 and 2018) explains, all these concepts are complementary: a taxonomy classifies assets and sectors according to their contribution to certain sustainability objectives, and based on this classification standards are defined for financial products that fulfil certain characteristics. Green label attests that a specific product complies with a particular standard. It is worth noting that an agreed taxonomy and greater transparency in the creation of green indices are important factors in creating credible green indices. See European Commission, 2018.

20 Greenwashing can also be described as “disinformation disseminated by an organisation so as to present an environmentally responsible public image.” (See: <https://en.oxforddictionaries.com/definition/greenwash>).

21 The lack of consensus and variety of definitions and taxonomies means that the People’s Bank of China’s (PBoC) standards consider clean-carbon projects to be green, whereas international standards do not.

standards and of consistency (for example, companies report on their contribution to combating climate change with reference to their own targets rather than common objectives, see OECD-CDSB, 2015), and the lack of enforcement measures or mechanisms for assessing supervisory financial information reporting quality (OECD-CDSB, 2015 and 2017). Added to this is the limited comparability of the various national standards and the differing levels of information required from companies in the same industry. Moreover, to be useful this disclosure must go beyond merely giving information about the company's carbon footprint and include information on the identification, management and integration of climate risks in the company.²² Additionally, climate information is usually presented separately from other financial information, making it more difficult for interested parties to find (OECD-CDSB, 2015 and 2017).

Disclosure of climate risk and its financial impact is particularly important for the banking industry as it is exposed to these risks more through its securities and loans portfolios than through the carbon footprint of its own activities (TCFD, 2017b). Climate risk is not a new risk category, but can be translated into existing categories, such as market risk and credit risk (BOE, 2017, TCFD, 2017b). Nevertheless, some banks may still consider environmental information to be a reputational issue associated with their corporate social responsibility rather than something to be included in their habitual risk management and global corporate strategy (see French Treasury, 2016). One of the reasons why it is not common for the financial sector to undertake an analysis of climate risk is the scarcity and complexity of the tools available to do so (TCFD, 2017a and b). In GFSG (2017), specific reasons are adduced for the limited accessibility of environmental methodologies and data,²³ such as the lack of specific knowledge, the analytical models' excessively short time horizons, and the lack of the consistent political signals that would enable the financial system to align itself with environmental sustainability (for example, it is difficult to stress test the financial system for transition risk if the government's strategic lines to encourage more sustainable economic development are unknown).

3.2 INITIATIVES, PROGRESS AND PROPOSALS

This section reviews the national initiatives and the private proposals for overcoming some of the obstacles holding back the expansion of green finance and the effective disclosure of climate risks by the financial and corporate sectors. It is worth noting that, in many cases, these proposals have not been developed in isolation, but have often influenced one another (for example, private sector initiatives have influenced those in the public sector) or there has been feedback between them (such as the French transition law and the recommendations of the High-Level Expert Group on Sustainable Finance, HLEG) (see section 4 as well).

3.2.1 National and private sector initiatives

The private sector was among the pioneers in looking for green standards and definitions enabling a degree of uniformity in the identification of these green instruments. In this context the initiative known as the Green Bond Principles (GBP), mentioned above, created by a group of investment banks in 2014, stands out, these principles having been key to the development of the green bond market (see Section 2.2). The cornerstone of these voluntary principles is the use of the proceeds of green bonds for projects with environmental

²² In other words, disclosure should include information on the link between carbon metrics and climate risks and opportunities and their financial impact (i.e. the impact of climate risks and opportunities on the balance sheet and income statement) (TCFD, 2017a).

²³ In its report, GFSG (2017) gave a compilation of some of the analytical tools used by the financial sector to include environmental risk (such as specific financial risk models, scenario analysis or financial ratings). Additionally there is the possibility of factoring these risks into some banks' stress testing frameworks (2DII, 2015a).

benefits that have to be evaluated and quantified by the issuer (ICMA, 2017a). In addition to these principles, internationally there are a number of other “green labels”, such as the “Climate Bond Standard and Certification”, developed by the Climate Bond Initiative (CBI), which establishes the criteria for verifying bonds’ green credentials and offers more concrete definitions than those of the GBP. In addition to international certifications, some countries and institutions have developed their own guidelines (for example, China and Brazil) or taxonomies, such as that of the European Investment Bank. Beyond the bond market, countries such as France have created green labels for funds (Energy and Ecological Transition for Climate Label and the SRI label).

There is also a number of initiatives seeking to foster specific financing structures, such as covered bonds and green securitisations, with additional advantages to those of a normal green bond.²⁴ Thus, unlike standard or generic bonds, where basically the company is required to increase or refinance its investment in a broad category of assets that are considered green, in the case of these other products the collateral for the financing instrument comprises a specific asset that has to comply with the necessary attributes to be classed as green. This encourages the identification of low-carbon assets on corporate balance sheets and facilitates standardisation.²⁵

This is particularly attractive in the case of covered bonds, given the importance of these instruments as a stable long-term source of bank finance and their resilience at times of market tension and uncertainty. Although they were initially created as a European fixed-income instrument, they have since expanded to other parts of the world, such as Canada and Australia, and receive special treatment in regulatory and resolution regulations. The features of these bonds make them an attractive way of stimulating green project finance, for several reasons: they are attractive instruments for institutional investors as they have a high degree of transparency of their collateral, can increase the bank financing of small value projects such as energy efficiency projects in the real-estate sector,²⁶ and the dynamic nature of their portfolio implies a constant flow of new green loans. The private sector is currently working on the creation of a European mortgage lending mechanism to promote the improvement of the energy efficiency of buildings or the purchase of energy efficient properties, as well as the gathering of data on the energy efficiency of mortgage assets.²⁷ To stimulate this market it is important that the legislation define precisely the characteristics of what is considered a covered bond (see Anguren *et al.*, 2013) and, in this connection, Luxembourg’s drafting of a legislative proposal to define the specific mode in which covered bonds are considered green, stands out.

Additionally, relevant initiatives have also been observed in the securitisations market. Unlike covered bonds, these instruments have static collateral (it is not renewed), but, by contrast, it can be used to provide liquidity for a wider range of bank assets, such as loans for electric cars or bank loans to small- and medium-sized enterprises (SMEs). Green securitisations have been issued in both the public and private sectors, one of the most significant cases being Fannie Mae, which last year became the largest issuer of green

24 Sovereign green bonds are also interesting instruments. These bonds create a long-term commitment to specific sustainable goals and strategies for the Governments issuing these bonds. Particularly noteworthy are the green sovereign bonds of Poland and France in 2016 and 2017, respectively.

25 Some of the banks that have issued green covered bonds have used energy performance certificates or buildings’ year of construction to define mortgage eligibility, thus speeding up the process of identifying green assets.

26 Other bonds may potentially also serve in this context, as Barclays showed in 2017 with the issue of a standard uncovered bond to finance green mortgages.

27 See the EMF-ECBC Initiative on Energy Efficient Mortgages.

bonds, according to the CBI (2018). In the case of the instruments designed by Fannie Mae, the certification of homes as energy efficient allows the mortgage to be used as security for a green bond and implies better financial conditions for the borrower. This represents clear incentives for owners to make improvements to boost their homes' energy efficiency, a particularly significant factor in the case of old buildings on which the loan is due for renewal (see Fannie Mae, 2012).

With a view to raising awareness and making the risks better known, there are a number of voluntary climate information disclosure initiatives in the investor sector, such as the Montreal Carbon Pledge and the Institutional Investors Group for Climate Change, as well as disclosure initiatives aimed at various sectors (for example, the Global Reporting Initiative's Sustainability Reporting Standards). At national level, 15 G20 countries, including the United Kingdom and the United States, have some form of compulsory standards for climate information, and the remainder, including Brazil, usually have at least voluntary information schemes (OECD-CDSB, 2017). Among the national regulations, Article 173 of the French energy transition and green growth law of August 2015 deserves a special mention. This includes requirements for disclosure of environmental information applicable to financial and non-financial corporations and institutional investors, with a clear focus on climate change.²⁸ Article 173 requires listed companies to report financial risks associated with the effects of climate change in their annual report, together with the measures taken to reduce them and the consequences of their activities for climate change. Moreover, provision VI of Article 173 goes beyond other disclosure standards by requiring institutional investors and larger asset managers to explain in their annual reports how they consider ESG criteria in their investment decisions and how their policies and objectives align with the national energy and transition strategy.²⁹ This legislation has received special attention because it aims to incorporate climate information in the annual report to give it more visibility and it tries to ensure that the effects of climate change on the company are taken into account (climate risk) together with the impact of the company's activities on climate change, which, moreover, are understood broadly (i.e. as they affect the whole value chain). The law also introduces climate change in the financial sector capital investment decisions and thereby puts additional pressure on non-financial corporations to provide more information to the financial sector (French Treasury, 2016, and FIR, 2016). Lastly, by signalling that investors and managers should align their efforts with the national climate change strategy, the standard establishes a common easy-to-monitor benchmark (OECD-CDSB, 2017). This highlights the importance of national legislators setting their climate objectives and strategies so as to enable effective disclosure of climate information (for example, through the Paris Agreement NDGs).

3.2.2 Initiatives by central banks and banking industry supervisors

In recent years the specific role that central banks and banking supervisors can play in developing initiatives to help overcome the obstacles to faster decarbonisation of the economy and compliance with the Paris Agreement has begun to be debated. Various areas of action have been identified. First, central banks usually accumulate considerable experience developing macroeconomic models examining the economic impact of various events, which could include the effects of climate change. However, there is a degree of

²⁸ There is a consensus that the provisions of this article are among the most advanced on disclosure as they solve some of the shortcomings of other similar standards (OECD-CDSB, 2017). So much so that HLEG (2018) proposes reforms to disclosure at the EU level based on experience implementing Article 173. Its provisions are additional to the environmental information obligations existing since 2010 (Grenelle II Law). Lastly, the law goes beyond climate change to deal with other topics such as ecosystem decline and resource depletion.

²⁹ The implementing decree for Article 173 (VI) is also characterised by its flexibility. After a two-year period of compiling information on the methodologies entities use, the government plans to define objectives and reference guidelines to enhance the comparability of the information these institutions publish.

consensus that the models traditionally used by central banks, such as dynamic stochastic general equilibrium models (commonly referred to as DSGE models) are not well suited to capturing the effects of climate change or the complexity of the economic transition. It is therefore necessary to develop alternative models that consider various sectors – whose activity has different carbon emission characteristics – where the financial sector plays an important role and in which the effect of extreme events can be taken into account (see, for example, Giraud *et al.*, 2017).

Moreover, central banks and supervisors perform an essential role in fostering the proper measurement of the risks faced by the financial sector, and therefore, in maintaining financial system stability. In this regard, some of these organisations have begun a preliminary analysis of the exposure of their financial sectors to climate risk or carbon-intensive activities, such as De Nederlandsche Bank (DNB, 2016 and 2017), the Swedish supervisory authority (Finansinspektionen, 2016) and the Bank of England.³⁰ These studies have generally concluded that the financial sector's risks or exposures are currently manageable, but when the analysis is expanded to include more sectors, or entities' foreign exposures are taken into account, the risk rises substantially (see table 1). As regards financial system stability, the majority of these studies detected no short- or medium-term risk, but highlighted that given the lack of information and the uncertainty about how these risks are likely to develop, it is still too early for a definitive conclusion. Moreover, the studies suggest that financial stability risks will be manageable only if the transition to a low-carbon economy is implemented soon, in an orderly way, and is predictable, and provided that the second-round effects and contagion between financial institutions are not severe.³¹ To conclude, despite recent progress, European supervisory authorities have warned that knowledge of climate risks and their impact on the financial sector remains limited. They therefore urge the competent authorities to improve their analysis in this area (Joint Committee of ESAs, 2018).

Another possibility is to conduct stress tests on the banking industry that take the climate risk banks face into account (the option suggested in Europe by De Nederlandsche Bank, the Bank of England and the ESRB, for example). These tests, which would help institutions internalise aspects such as the climate risk of their investments, not only require a degree of international coordination (to define comparable scenarios and exposures) but also coordination with national authorities (to design carbon-emission reduction scenarios in line with each country's energy strategy). Regulators also have the possibility of reviewing prudential regulations to check whether climate risks are adequately considered.³²

Central banks may also consider ways of incorporating climate risk in their investment management (both as regards international reserves and, in the case of certain central banks, sovereign wealth funds) or in the area of monetary policy. Clearly, all these decisions

30 In 2015 the Bank of England undertook an analysis of this type on the UK insurance sector and since extended its analysis to the banking industry. The Bank has announced that it intends to perform further analysis using more granular data for insurance companies, and proposes to include climate factors in the stress tests (see BoE, 2015 and 2017). For its part, the People's Bank of China, in cooperation with other bodies, has expressed its support for including climate risk in the banking industry and institutional investor stress tests.

31 Along these lines, the ESRB (2016) considers the potential for systemic contagion to be very high, particularly if climate exposure is concentrated in a few large banks or in specific countries. Battiston *et al.* (2016) reach a similar conclusion.

32 The importance of developing sufficient green infrastructure and finding long-term financing for its construction makes the growing debate as to whether current banking capital regulations (Basel III) indirectly harm long-term sustainable financing such as project finance of interest (see HLEG, 2018 and CISL and UNEP-FI, 2014). There is also a debate about the inclusion of either a factor penalising capital for high carbon-risk investments or capital relief for bank investments in assets with environmental benefits.

have to be compatible with the mandate established for these entities. In this regard, it comes as no surprise that in some emerging countries, where the central bank's mandate is relatively wide, further-reaching measures have been included, such as establishing financing on preferential terms or lending quotas to foster green loans (for example, Bangladesh Bank, Reserve Bank of India, Bank of Lebanon).

4 International coordination

The set of policies mentioned in the previous section can contribute, from various angles, to mobilising the financing necessary to transform the economy towards a productive model along the lines set out in the Paris Agreement. However, these policies may be insufficient unless there is a certain degree of international coordination. Coordination is needed not only to achieve the climate change objectives – as climate change does not usually stop at borders – but also to enable compliance with the measures intended to mobilise capital and raise awareness about the issue. This coordination needs to be international, given the extent of globalisation of capital flows and the potential scale of some of the projects aiming to adapt or develop new infrastructure to encourage more efficient resource consumption. Moreover, it is obvious that climate change is a global phenomenon and should be managed with a global approach.

In order to make headway on international coordination in these areas, various initiatives have been developed in recent years to foster or stimulate green or sustainable finance. First it is worth noting that in 2016, the G20, under China's presidency, launched a study group to identify the main challenges and difficulties in developing green finance in various areas such as investment funds, banks or capital markets. This first G20 initiative gave rise to the Green Finance Study Group Report (GFSG, 2016) and served as a starting point for international experience sharing, while signalling the major countries' political commitment to developing measures to enhance the financial system's sensitivity to climate risk and internalise it in decision-making. Germany's subsequent G20 presidency confirmed this commitment and continued efforts to compile information and conduct analysis on the issue. Lastly, in 2018, under the presidency of Argentina, the G20 set up a study group on sustainable finance focusing on three lines of action: investigating measures to boost institutional investors' commitment to financing sustainable projects, discussing sustainable initiatives in the venture capital area, and analysing the opportunities arising in the world of new technologies applied to sustainable finance (green FinTech).

More specifically, the Financial Stability Board (FSB) set up a working group comprising various financial market participants in order to draw up voluntary recommendations to guide companies on the type of information they are to provide to market participants in relation to the risk associated with climate change. This group issued its final report in June 2017 (TCFD, 2017a) and its recommendations consider the physical risks, the transition risks and the opportunities associated with climate change. The group also established both general considerations and specific disclosure recommendations for particular sectors.

Other international organisations have also designed initiatives either to back national measures to combat climate change, as in the case of the United Nations, or support the development of specific instruments, such as green bonds, in the case of the OECD. In the case of the latter, a Green Finance and Investment Centre was also set up in 2016 to facilitate the use of the institution's analytical capacity to further develop sustainable finance.

A number of initiatives at regional level are also worth mentioning. Specifically, in the European Union,³³ the need to stimulate sustainable finance has been acknowledged in communiqués from the European Commission, Council and Parliament. In order to coordinate the measures to be implemented, a high level expert group was set up in the capital markets union, which published a report in January 2018 with recommendations on the development of green bond markets and on information disclosure practices for sustainability risk or changes in governance and supervisors' mandates (HLEG, 2018). These recommendations were the basis of the Action Plan announced by the European Commission, which includes measures to redirect capital towards a more sustainable economy, introduce sustainability in risk management, and foster transparency and a long-term vision in economic and financial activity (European Commission, 2018). To this end, the Commission will focus its efforts on the creation of an EU-wide sustainability taxonomy that, starting with the climate aspect, should lead to a legislative proposal in the third quarter of 2019. Moreover, this taxonomy will be the first step towards creating benchmark indices, standards and certificates for green products. Other measures in the Action Plan focus on strengthening sustainability disclosure, integrating sustainability in the provision of financial advice, establishing a fiduciary duty regarding sustainability for asset managers and institutional investors, and incorporating sustainability in the prudential requirements for banks and insurance companies. Implementation of these strategies over the coming months will entail a combination of legislative and non-legislative actions and reform of existing standards.

Lastly, central banks and supervisors are also involved in these initiatives and, as seen in the previous section, there are a number of measures that can be taken to encourage the decarbonisation of the economy. In this regard, in late 2017 a small group of central banks and supervisors set up the Central Banks and Supervisors Network for Greening the Financial System (NGFS, 2017). This group, initially comprising representatives of eight central banks and supervisors, was recently joined by further members, including the Banco de España.³⁴ The group's aim is to share experience and establish good practice in relation to climate change risk, and unite efforts in the supervisory area, in the modelling of the implications for economic activity and in promoting markets that explicitly identify this risk.

5 Conclusions

The Paris Agreement represents the recognition, with an unprecedented degree of consensus, that there is a need to take action to help mitigate climate change and guide economies towards sustainable parameters, while also improving the resilience of the economy and society to the effects of alterations taking place in the climate. To this end, as the agreement spells out, the involvement of the financial sector is essential, given the scale of resources necessary to finance a new productive model.

The financial sector has a crucial contribution to make to this major challenge, going beyond identifying and flagging projects considered green so that they can be singled out for funding, to include aspects such as the quantification of different types of the risk associated with climate change. In this regard, it is necessary for the financial sector to

³³ Regional initiatives have also been developed in Asia, such as the ASEAN Capital Markets Forum, which aims to set standards for green bonds issued by the countries of the region.

³⁴ There were eight founding members: Banco de México, the Bank of England, Banque de France/the French Prudential Supervision and Resolution Authority (Autorité de contrôle prudentiel et de résolution - ACPR), De Nederlandsche Bank, the Deutsche Bundesbank, Finansinspektionen (the Swedish financial supervisory authority), the Monetary Authority of Singapore, and the People's Bank of China (PBoC).

consider sustainability and climate risk as more than a merely reputational matter, but also as a relevant topic in risk analysis and management areas.

Accordingly, in this article we have sought to answer the question whether the markets are internalising climate risk and have reviewed the various initiatives carried out in the private and public sectors in recent years in order to improve the valuation of climate risk in financial operators' decisions. The appraisal has so far been positive on various metrics: issuance and the variety of issuers and instruments taking climate-change aspects into account have increased; the number of green bond and equity indices has grown (and they seem to be yielding positive returns); bank finance to sectors such as renewable energy has increased; there is a multitude of initiatives by public authorities promoting green financing, and organisations such as central banks, which until recently stayed out of the debate, have become involved. Moreover, the international consensus on the fight against climate change has also been observed in the financial world and both the G20 and European Union have fostered initiatives to strengthen the role of the financial system in assigning resources in a way compatible with more sustainable economic development.

However, despite the cumulative progress made over this short period, and the trends observed in the public and private sectors, financial markets and banking institutions do not seem to have fully internalised climate risk in their decision-making. There are a number of factors underlying this situation, but the lack of disclosure by companies, absence of a common taxonomy for classifying what is considered green, and the lack of experience quantifying climate risks and opportunities, are probably the main factors that need to be addressed most urgently.

Additionally, regulators should include climate risk among the factors that may affect financial stability. However, to factor climate risk into stress tests, the corresponding government climate change strategy needs to be known in sufficient detail. This strategy allows the sectors and time scales in which losses during the transition to a decarbonised economy may be concentrated to be identified. In this regard, the banking industry has made a strong contribution to the development of common standards and the creation of green financial instruments – highly valuable initiatives, which have facilitated the valuation of climate risk. Nevertheless, there are areas in which less progress has been made, such as the involvement of risk departments in climate-change issues and innovation to foster the spread of financial instruments facilitating more sustainable investments.

Finally, only through more coordinated action by all concerned will it be possible avoid the tragedy of the horizon referred to by Mark Carney. In other words, only by anticipating the difficulties and taking appropriate measures rapidly and effectively can the climate tragedy be prevented from materialising. Only thus will be able to avoid regretting not having acted much sooner, while there was still time.

REFERENCES

- 2 DII (2015a). *Financial risk and the transition to a low carbon economy: towards a carbon stress testing framework*, Working Paper, July.
- (2015b). *Carbon intensity = /carbon risk exposure*, Discussion Paper, November.
- ANGUREN, R., J. M. MARQUÉS SEVILLANO and L. ROMO GONZÁLEZ (2013). «Covered bonds: the renaissance of an old acquaintance», *Revista de Estabilidad Financiera*, No. 24, pp. 69-87.
- ALLEN, M., D. FRAME, C. HUNTINGFORD, C. JONES, J. LOWE and N. MEINSHAUSEN (2009). «Warning caused by cumulative carbon emissions towards the trillionth tonne», *Nature*, 458 (7242), pp. 1163-1166.
- BANK FOR INTERNATIONAL SETTLEMENTS (2017). «Green bond finance and certification», *BIS Quarterly Review*, September.
- BARCLAYS (2015). «The Cost of Being Green», *Credit Research*, 18 September.
- BATTISTON, S., A. MANDEL, I. MONASTEROLO, F. SCHÜTZE and G. VISENTIN (2016). *A climate stress-test of the financial system*, Working Paper, 11 July edition.

- BLOOMBERG (2017). *Bloomberg Barclays MSCI Global Green Bond Index*, June.
- BOE (BANK OF ENGLAND) (2015). *The impact of climate change on the UK insurance sector*, Bank of England Prudential Regulation Authority, September.
- (2017). «The Bank of England's response to climate change», Topical Articles, *Quarterly Bulletin*, Q2.
- CBI (CLIMATE BONDS INITIATIVE) (2018). *Green Bond Highlights 2017*, January.
- CISL and UNEP-FI (CAMBRIDGE INSTITUTE FOR SUSTAINABILITY LEADERSHIP and UNEP FINANCE INITIATIVE) (2014). *Stability and Sustainability in Banking Reform: Are Environmental Risks Missing in Basel III?*, August.
- CTI (CARBON TRACK INITIATIVE) (2011). *Unburnable Carbon-Are the World's Financial Markets Carrying a Carbon Bubble?*
- (2013). *Unburnable Carbon 2013: Wasted Capital and Stranded Assets*.
- CARNEY, M. (2015). *Breaking the tragedy of the horizon-climate change and financial stability*, speech at Lloyd's of London, 29 September.
- COMISIÓN EUROPEA (2018). *Action Plan: Financing Sustainable Growth, Communication*, COM (2017) 97 final, March.
- DEUTSCHE ASSET MANAGEMENT and GLOBAL RESEARCH INSTITUTE (2017). *Measuring physical climate risk in equity portfolio*, November.
- DNB (DE NEDERLANDSCHE BANK) (2016). *Time for Transition*, Occasional Studies, vol. 14-2.
- (2017). *Waterproof? An exploration of climate-related risks for the Dutch financial sector*.
- EDESSES, M. (2015). «Catastrophe Bonds: An Important New Financial Instrument», *Alternative Investment Analyst Review*, Autumn.
- ESA (JOINT COMMITTEE OF THE EUROPEAN SUPERVISORY AUTHORITIES) (2018). *Joint committee report on risks and vulnerabilities in the EU financial system*, April.
- ESRB (EUROPEAN SYSTEMIC RISK BOARD) (2016). «Too late, too sudden: transition to a low-carbon economy and systemic risk», *Reports of the Advisory Scientific Committee*, No. 6, February.
- FANNIE MAE (2012). *Multifamily Green Initiative*, Second Quarter.
- FEDERAL MINISTRY OF FINANCE (2016). *Climate change and financial markets*, September.
- FINANSINSPEKTIONEN (2016). *Climate change and financial stability*, March.
- FIR (FORUM POUR L' INVESTISSEMENT RESPONSIBLE) (2016). «Article 173-VI: Understanding the French regulation on investor climate reporting», *FIR Handbook 1*, October.
- FRENCH TREASURY (2016). *Assessing climate change-related risks in the banking sector*, in collaboration with the Banque de France and the Autorité de Contrôle Prudentiel et de Résolution.
- GFSG (G20 GREEN FINANCE STUDY GROUP) (2016). *G20 Green Finance Synthesis Report*, September.
- (2017). *G20 Green Finance Synthesis Report*, July.
- GIRAUD, G., F. MCISAAC and E. BOVARI (2017). *Coping with collapse: a stock-flow consistent monetary macrodynamics of global warming*, Working Paper, version 23 October, Agence Française de Développement and University of Paris.
- GÖRGEN, M., A. JACOB, M. NERLINGER, M. ROHLEDER and M. WILKENS (2017). *Carbon risk*, Working Paper, University of Augsburg.
- GRIFFIN, P. A., A. MYERS JAFFE, D. H. LONT and R. DOMÍNGUEZ-FAUS (2015). «Science and the stock market: investors' recognition of unburnable carbon», *Energy Economics*, 52, pp. 1-12.
- HIERZIG, S. (2017). «Banking on a Low-Carbon Future. A Ranking of the 15 Largest European Banks' Responses to Climate Change», *Survey & Ranking*, December, ShareAction.
- HLEG (HIGH-LEVEL EXPERT GROUP ON SUSTAINABLE FINANCE) (2017). *Financing a Sustainable European Economy*, Interim Report, July.
- (2018). *Financing a Sustainable European Economy*, Final Report, January.
- HOFFMAN, V. H., and T. BUSCH (2008). «Corporate Carbon Performance Indicators», *Journal of Industry Ecology*, 12(4), pp. 505-520.
- ICMA (INTERNATIONAL CAPITAL MARKET ASSOCIATION) (2017a). *The Green Bond Principles*, 2 June.
- (2017b). *The GBP Databases and Indices Working Group – Summary of Green Fixed Income Indices Providers*, June.
- IEA (INTERNATIONAL ENERGY AGENCY) (2017). *World Energy Outlook, 2017*.
- IPCC (INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE) (2014). *Climate change 2014 synthesis report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* [Core Writing Team, R. K. Pachauri and L. A. Meyer (eds.)], IPCC, Geneva, Switzerland.
- (2017). *Infographic: The Global Carbon Budget*, <http://www.wri.org/ipcc-infographics>.
- JUNG, J., K. HERBOHN and P. CLARKSON (2014). *The impact of a firm's carbon risk profile on the cost of debt capital: evidence from Australian firms*, Working Paper, UQ Business School, The University of Queensland.
- KAMINKER, C., C. MAJOWSKI and R. SULLIVAN (2017). *Green Bonds – Ecosystem, Issuance Process and Case Studies*, Consultation Draft, Federal Ministry for Economic Cooperation and Development and SEB.
- MARLIN, S. (2018). «Banks begin to model climate risk in loan portfolios», *Risk.net*, 16 January.
- MEINSHAUSEN, M., N. MEINSHAUSEN, W. HARE, S. RAPER, K. FIELER, R. KNUTTI, D. FRAME and M. ALLEN (2009). «Greenhouse-gas emission targets for limiting global warming to 2 degrees C», *Nature*, 458 (7242), pp. 1158-1163.
- MSCI (2015). *Carbon Footprinting 101. A practical guide to understanding and applying carbon metrics*, September.
- NGFS (CENTRAL BANKS AND SUPERVISORS NETWORK FOR GREENING THE FINANCIAL SYSTEM) (2017). *Joint Statement by the Founding Members of the Central Banks and Supervisors Network for Greening the Financial System*, December.
- OCDE-CDSB (2015). «Climate change disclosure in G20 countries. Stocktaking of corporate reporting schemes», *Responsible Business Conduct*.
- (2017). *Corporate disclosure schemes in G20 countries after COP21*, paper provided to the OECD in the context of the project «Growth, investment and the low carbon transition».

RAINFOREST ACTION NETWORK, BANKTRACK, INDIGENOUS ENVIRONMENTAL NETWORK, OIL CHANGE INTERNATIONAL, SIERRA CLUB and HONOR THE EARTH (2018). «Banking on climate change», *Fossil Fuel Finance Report Card 2018*.

ROBINS, N., and J. McDANIELS (2016). *Greening the banking system. Taking stock of G-20 green banking market practice*, Inquiry Working Paper 16/12, September.

TCFD (TASK FORCE ON CLIMATE-RELATED FINANCIAL DISCLOSURES) (2017a). *Recommendations of the Task Force on Climate-related Financial Disclosures*, Final Report, June.

– (2017b). *Implementing the recommendations of the Task Force on Climate-related Financial Disclosures*, June.

VIELHABER, R. (2017). «Green Bonds: The Chartbook», *Unicredit*, November.

VOLZ, U. (2017). *On the role of central banks in enhancing green finance*, UN Environment Inquiry/CIGI Research Convening, Inquiry Working Paper 17/01, February.

WEYZIG, F., B. KUEPPER, J. W. VAN GELDER and R. VAN TILBURG (2014). *The Price of Doing Too Little Too Late; the Impact of the Carbon Bubble on the European Financial System*, Green New Deal Series, vol. 11.

WORLD ENERGY COUNCIL (2017). *World Energy Resources. Solar 2016*.

WRI and UNEP-FI (WORLD RESOURCES INSTITUTE and UNITED NATIONS ENVIRONMENT PROGRAMME FINANCE INITIATIVE PORTFOLIO CARBON INITIATIVE) (2015). *Carbon Asset Risk: Discussion Framework* (primary authors: M. Fulton and C. Weber).

ZERBIB, O. D. (2017). *The Green Bond Premium*, Working Paper, University of Tiburg, October.