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The Price of Doing Too Little Too Late

The impact of the carbon bubble on the EU financial system

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Green New Deal Series volume 11

The Price of Doing Too Little Too Late

The impact of the carbon bubble on the EU financial system

A report prepared for the Greens/EFA Group – European Parliament

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Foreword

Our financial system has gone through a variety of bubbles. The real estate bubble, the commodity bubble, the dot-com bubble. A potential new one is emerging: the carbon bubble.

Public and private financial institutions continue to pour millions into fossil fuel companies, inflating their share prices, as if their fossil reserves will always sell on the market. This is a wrong assumption. Instead, if we are serious about limiting global warming to 2 degrees Celsius, these reserves must be kept firmly in the ground, which would turn them into stranded financial assets. McKinsey and the Carbon Trust have calculated that this could endanger more than 30-40% of company value. Popping this bubble could therefore create a carbon shock with severe consequences for our financial system.

With this study, we want to follow the money trail behind the carbon bubble and analyse the resilience of our financial system against a possible carbon shock. For this purpose, the study has investigated the exposure in high-carbon assets of 43 of the EU's largest banks and pension funds and calculated their potential losses under a variety of scenarios.

The result is sobering. With a total estimated exposure to high carbon assets of over €1 trillion for these institutions, there is ground for serious concern. A number of individual actors and Member States are particularly at risk. The most vulnerable financial institutions include two of Europe's largest banks in France and a number of sizeable pension funds in the United Kingdom and the Netherlands. Yet again for other Member States, such as Germany, a lack of transparency has hidden their carbon exposure.

But there is hope. The study comes to the conclusion that to mitigate the carbon bubble, the most cost-effective pathway would be the determined pursuit of ambitious climate and energy policies leading to a quick and decisive transition to a low-carbon economy. A slow and uncertain transition – as indeed the European Commission is proposing with its 2030 energy and climate targets – would in the end cause larger losses while a scenario where no climate action is taken would lead to the highest financial, social and environmental cost. The study illustrates the price of doing too little too late.

This is still relatively uncharted territory and, with this study, the Greens/EFA, are breaking new ground. The study shows that the carbon bubble matters for financial institutions and we hope that it may act as a wake-up call for regulators, policymakers and the financial institutions themselves.

In this vein, we would like to sincerely thank the authors for shedding more light on this complex issue as well as the Green European Foundation for making sure that this important work reaches the widest possible audience and contributes to a European debate.

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Executive summary

The carbon bubble means that fossil fuel-related assets are overvalued

The carbon bubble refers to the overvaluation of fossil fuel reserves and related assets should the world meet its stated objective of limiting climate change. Avoiding uncontrollable climate change means we must limit the rise in global surface temperature to 2°C compared to the pre-industrial age. Meeting this target puts a limit on future carbon dioxide (CO_2) emissions and hence on the amount of fossil fuels that can be burned. The current global reserves of oil, gas and coal are several times larger than this limit, even if emissions are progressively reduced via carbon capture and storage. This means that the majority of fossil fuel reserves are stranded assets: they cannot be used if harmful climate change is to be avoided. Stranded assets can also result from technological developments that quickly reduce the demand for fossil fuels.

Stranded carbon assets affect various business sectors and governments

Private oil, gas and coal mining companies own about a quarter of fossil fuel reserves. If a large part of these reserves cannot be extracted or extraction becomes commercially unviable, that reduces the valuation of these companies and their ability to repay their debt. Policies to limit climate change would also affect other businesses that cause high greenhouse gas emissions. A transition driven by technological developments could cause a negative shock to electricity producers, while reducing production costs for some other sectors. Moreover, governments owning fossil fuel reserves would be faced with a fall in revenues, reducing the value of the sovereign bonds they have issued.

This report estimates the exposures of EU financial institutions to fossil fuel firms and commodities This report analyses a key component of the potential impact of the carbon bubble on the EU financial system. It estimates the exposures of 23 large EU pension funds and the 20 largest EU banks to oil, gas and coal mining firms. For equity investments and corporate loans, the analysis identifies individual shareholdings in, and syndicated loans to, approximately one thousand fossil fuel firms, using financial databases. For corporate bonds, it makes a rough estimate of the exposures of financial institutions on the basis of their general asset distribution and bond market indices. Pension fund investments in fossil fuel commodities are estimated as well. The exposures of the investigated financial institutions are then scaled up to the total EU pension sector and all EU-based banks. The report also estimates exposures for the EU insurance sector, using aggregated data on the asset composition of insurance companies. The exposures relate to fossil fuel firms and commodities only and do not cover exposures to other sectors that could be affected by the carbon bubble, which are also substantial. The estimates are based on externally available data and have not been verified by the financial institutions.

Total exposures exceed €1 trillion

Equity, bond and credit exposures of EU financial institutions to firms holding fossil fuel reserves and to fossil fuel commodities are substantial. The total estimated exposures are approximately € 260-330 billion for EU pension funds, € 460-480 billion for banks and € 300-400 billion for insurance companies. Such large figures raise serious concerns about the potential consequences of these investments if a large part of the oil, gas and coal reserves ends up stranded. The estimated exposures are approximately 5% of total assets for pension funds, 4% for insurance companies and 1.4% for banks.

A carbon bubble shock would cause significant losses for EU financial institutions

Using these exposure data, this report analyses the potential impact of a carbon bubble shock. The main shock scenario, called "Low-carbon Breakthrough", consists of a quick and definite transition to a low-carbon economy. It assumes losses on exposures to fossil fuel firms ranging from 60% on equity investments to 20% on credit facilities. This scenario causes average losses on the order of 3% of total assets for pension funds, 2% for insurance companies and 0.4% for large banks. The losses for all EU banks, insurance companies and pension funds combined would be € 350-400 billion.

A slow transition will be more costly

A second "Uncertain Transition" scenario assumes that emissions will eventually remain within the carbon budget, but with a transition path that is initially slow and highly uncertain. This increases the losses for financial institutions, because fossil fuel firms will continue to make large investments to develop new reserves, increasing the amount of stranded assets. Annual capital expenditures of large oil and gas firms are approximately € 500 billion, which is high compared to, for example, the total market capitalisation of these firms which stands at roughly € 3 trillion. In addition, significant uncertainty about future developments could itself become a source of financial instability due to doubt regarding the valuation of high-carbon businesses and fears about hidden losses at financial institutions.

Doing nothing causes the largest risks

The analysis also considers a "Carbon Renaissance" scenario, characterised by quickly increasing demand for fossil fuels and ineffective climate policies. This will eventually lead to catastrophic climate change and increased sea levels, floods, droughts, and extreme storms and rainfalls. Existing studies indicate that this scenario causes the largest losses for financial institutions as it seriously harms the global economy and generates large claims for insurance companies.

The carbon bubble alone is unlikely to be a source of systemic risk

On its own, the shock to financial institutions resulting from a quick adoption of climate and energy policies or a breakthrough in low-carbon technology is unlikely to be a source of systemic risk. Carbon bubble risks, while significant, are not so large that they pose a threat to the pension, banking and insurance sectors as a whole. A carbon bubble shock alone is therefore unlikely to trigger harmful feedback loops within the financial system, for example via a flight to safe assets, or between the financial system and the broader economy, for example via a credit squeeze. Thus, risks to financial stability are currently not an obstacle to the adoption of effective climate policies. However, in the case of continued economic fragility in the Eurozone, a carbon bubble shock would come on top of other causes of financial instability and would be more difficult to absorb. Furthermore, this report estimates only the potential losses on exposures to fossil fuel firms and commodities. The total impact of a carbon bubble shock will be larger through the impact on other sectors and investments.

Individual institutions and national sectors are threatened

For individual institutions or EU countries, carbon bubble risks can be much larger. Although a precise ranking is not possible, the analysis shows that many pension funds from the UK have a large exposure to the carbon bubble. These include the Universities Superannuation Scheme and BAE Systems Pension Scheme. Dutch PFZW and Finnish Keva also seem relatively exposed. Under the "Low-carbon Breakthrough" scenario, these funds could lose approximately 3-7% of their assets due to exposures to fossil fuel firms and commodities. Banks that might suffer relatively large losses include Lloyds Banking Group, Société Générale, BNP Paribas and Standard Chartered. These banks could lose an estimated 0.6-0.8% of total assets on their exposures to oil, gas and coal mining firms. At the national level, the UK and the Netherlands are vulnerable because of the large exposures of their pension sectors. France is vulnerable due to the high exposure of BNP Paribas and Société Générale.

Adequate climate and energy policies help to minimise losses

To reduce uncertainty for financial institutions, it is crucial to adopt clear and effective long-term climate and energy policies. A credible EU policy will discourage investments in firms holding stranded assets and other high-carbon business and at the same time boost investments in cleaner technology and energy saving businesses. Adequate climate and energy policies are also the most effective way to prevent wasteful capital expenditures by fossil fuel firms that would eventually increase losses for financial institutions.

Supervisory assessments are needed

Carbon bubble risks differ considerably between financial institutions. This report provides best estimates based on external data. A further assessment of large EU banks, insurance companies and pension funds is warranted to fully determine the risks. This could involve a 'carbon stress test' for financial institutions. Weaknesses in the risk management or risk-bearing capacity of individual institutions may mandate supervisory measures. If national sectors as a whole are vulnerable, macroprudential authorities should take steps to safeguard financial stability.

Active long-term investment strategies help to manage carbon bubble risks

The EU can promote active long-term investment strategies as a good practice for pension funds and insurance companies. Active long-term investment strategies, as opposed to passive or short-term investment approaches, will be conducive to better management of carbon bubble risks. Pension funds and insurance companies should also incorporate explicit long-term objectives and long-term incentive structures for fund managers into their investment mandates.

Introduction

Motivation and objective

The carbon bubble refers to the overvaluation of oil, gas and coal mining companies because of the need to shift from fossil fuels to renewable ones. The logic behind this is simple. First, to avoid harmful climate change, the rise of average global surface temperature since the industrial age should be limited to, at most, 2°C. Second, meeting this target puts a limit on future carbon dioxide (CO_2) emissions and hence on the amount of fossil fuels that can be burnt. The current global reserves of oil, gas and coal are several times larger than this limit. This means that the majority of fossil fuel reserves are stranded assets: they cannot be used if harmful climate change is to be avoided. Third, private companies own about a quarter of fossil fuel reserves. If a large part of these reserves cannot be extracted, that reduces the valuation of these companies and their ability to repay their debt.

The carbon bubble poses risks to the financial sector because financial institutions have large exposures to oil, gas and coal mining companies through equity, bond, and loan portfolios. The Greens/EFA Group in the European Parliament commissioned this study to assess those risks. The report has been prepared by the Sustainable Finance Lab, a network of 16 leading Dutch academics and experts promoting a more sustainable financial sector, and Profundo, an economic research consultancy with a focus on the financial sector, corporate social responsibility, and commodity chains. The objective of the study is to determine the potential impact of the carbon bubble on the EU financial system. Considering that this impact could be serious, the report develops recommendations to limit the adverse effects of the carbon bubble and to facilitate a greening of financial markets.

The current study builds on previous reports about the carbon bubble, notably by the Carbon Tracker Initiative. Those reports already provide an overview of listed companies with the largest estimated carbon reserves and of the carbon intensity of major stock exchanges [1]. A key contribution of this report is that it estimates the exposures of the EU financial sector to companies with large carbon reserves. It focuses on companies with oil, gas and coal reserves, which the carbon bubble affects most directly. A second key contribution is that it describes how different transitions towards a low-carbon economy could impact the EU financial system and how this could cause shocks to the economy. The report shows that the impact does not only depend on the exposure of financial institutions, but also on the speed and uncertainty of the adjustment scenario and on the way investors respond to it. In addition to two transition scenarios, the report also briefly discusses the consequences of a high-carbon scenario for the financial sector.

Methodology

Note that this study focuses on potential losses due to exposures to extractive firms owning oil, gas and coal assets. It does not provide a quantitative analysis of exposures to other high-carbon industries, such as electricity, steel and transport, which will also be strongly affected [2, 3]. Furthermore, the study does not consider investments in renewable energy and clean technology that would increase in value as a result of further action being taken against climate change. The estimates of potential losses therefore provide only a first indication of the effect of the carbon bubble on financial institutions. The focus of the report is on impacts on the EU financial system. The analysis takes into account that large EU pension funds, banks and insurance companies have exposures to the extractive industry worldwide.

The analysis in the report is based on data from the publicly available information of financial institutions and Thomson ONE databases. Due to the limited size of the research project, no additional data were collected from the banks and pension funds under investigation. Furthermore, the findings have not been verified by all the financial institutions themselves. The exposures and potential losses calculated in the report should therefore be interpreted as best estimates on the basis of externally available data. The authors gratefully acknowledge input for the analysis from Herman Wijffels, Cormac Petit, James Vaccaro, Pieter van Stijn, Erik-Jan Stork, Wilfred Nagel, Jaap Jan Prins, and Roderick Kefferpütz.

Outline

The outline of the report is as follows. First, a background chapter discusses existing reports about the carbon bubble and the risks for financial institutions. It also briefly describes some initiatives to address these risks. The following three chapters analyse the exposures of large EU pension funds, banks, and insurance companies to fossil fuel companies. The chapters on pension funds and banks describe the exposures of large individual institutions and extrapolate this to the entire EU pension and banking sectors. The chapter on insurance companies provides estimates for the total EU insurance sector only. After that, the next chapter quantitatively analyses the impact of a "Low-carbon Breakthrough" scenario that assumes a sudden carbon bubble shock. It also discusses two alternative scenarios, an "Uncertain Transition" and a "Carbon Renaissance". The last two chapters contain overall conclusions and recommendations.

Background

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The two degrees constraint

This background chapter discusses a range of existing reports that provide important inputs for the current study.

The Carbon Tracker Initiative has estimated the amount of stranded assets if global warming is to be limited to two degrees in its Unburnable Carbon reports published in 2011 and 2013. The initial estimate of the CO_2 emissions budget up to 2050 was 565 billion tons (Gt) [4]. An alternative estimate, accepting a lower probability of staying below the two degrees target, increases the budget to 886 Gt. Further relaxed assumptions, allowing for stronger reductions of other greenhouse gases such as methane and the increased mitigation of CO_2 emissions through carbon capture and storage, may increase the total CO_2 budget to 1,200 Gt [5]. Burning all current global reserves would generate CO_2 emissions of approximately 2,860 Gt. Thus, depending on the assumptions made, only 20-40% of the current proven reserves can be used. The carbon budget for the period 2051-2100 will be much lower, a mere 75 Gt.

The burden of stranded assets can be distributed in different ways. First, the equity and bond exposures analysed in the current report concern private companies and these may bear a smaller or larger share of the burden. If they must scale down production proportionately, as assumed in the Unburnable Carbon reports, only 20-40% of their fossil fuel assets can be sold. However, private companies own only a quarter of the total fossil fuel reserves as measured by CO_2 emissions potential. Thus, it is possible that government-owned assets will absorb a larger part of the losses, but the budget of private companies could also be further reduced.

Second, the allocation of the CO_2 emissions budget may favour cleaner and more efficient types of fossil fuels. This would imply that coal reserves remain largely unused, because coal is the most polluting type of fossil fuel, producing the largest CO_2 emissions per unit of power generated. Coal reserves represent about two-thirds of potential CO_2 emissions. Unconventional oil reserves, such as tar sands, would also remain largely unused. By contrast, the budget for conventional oil could then be slightly increased, depending on the assumptions made in calculating acceptable emissions. Conventional gas reserves, which are cleanest and most energy efficient, could be fully extracted [6].

Approximately 20% of coal, 50% of conventional oil and 10% of global gas reserves are owned by 200 large private companies [7]. Thus, depending on the distribution of the CO_2 emissions budget, the value of private coal companies could be most severely affected by stranded assets. Moreover, the value of private oil companies will be affected, as part of global oil reserves will be stranded almost regardless of the emissions budget distribution and private companies own a relatively large share of those reserves.

Effects of a low-carbon economy on firm value

The transition to a low-carbon economy will affect the value of carbon-intensive firms. In a 2008 study, McKinsey and the Carbon Trust showed that more than half of the share value of oil and gas companies results from future cash flows generated after more than 10 years. They estimated that 30-40% of company value is at risk in this sector because of lower anticipated demand for fossil fuels, reducing oil and gas prices. The analysis notes that changes may be driven by shifts in regulation, but also in technology and consumer behavior; it does not mention stranded assets. The transformation towards a low-carbon economy will also affect other industries, such as vehicle manufacture. In these sectors an even larger part of company value is at stake, but this is offset by a potential for value creation, for example by switching to hybrid and electric cars. For extractive industries, alternative opportunities besides renewable energy are very limited. Finally, there are also sectors like building insulation with low value-at-risk that will benefit from enhanced opportunities if regulation were to increase energy prices for end users [8]. Investments in these sectors could act as natural hedges to high-carbon investments, but their current market size is relatively limited.

HSBC analysed the potential effect of a two degrees scenario on the market value of oil, gas and coal mining firms. It notes that the risks have not been considered yet in share valuations by investors. HSBC finds that the carbon constraints could reduce the current value of coal reserves by more than 40%. The impact on market value differs from company to company as some mining firms have diversified operations, derive a large part of their income from metals and have only a small exposure to coal. Focusing on UK-based mining companies, the analysis finds that Xstrata, which derives a third of its income from coal, could lose

up to 15% of its value [9]. For a pure coal mining company, the effect will be much larger (and if climate change is addressed by phasing out coal altogether, coal mining operations will lose virtually all of their value). Regarding publicly listed oil and gas companies, HSBC bases its calculations on downward price adjustments, assuming a price level of USD 50 per barrel for oil and an equivalent price of USD 55 per barrel for gas. As a result of the lower prices, high cost projects will be cancelled. The value of unburnable fossil fuel reserves differs considerably from company to company, but the effect on equity valuations for most companies would lie in the range of 40-60% [10]. The effect can be illustrated with the 20% downward adjustment of estimated reserves by Shell in 2004, which led to a quick fall in share prices of 10% [11]. It is generally perceived that financial markets have not yet priced in carbon bubble risks because strong climate policies are considered highly unlikely.

Standard and Poor's analysed the effect of lower oil prices on the creditworthiness of firms engaged in oil sands operations, a form of unconventional oil with high production costs. Especially for small companies with a large exposure to oil sands, there would be a risk of credit downgrades, reducing the value of their bonds [12]. More generally, companies that are largely dependent on coal mining or high cost oil projects are vulnerable to shocks and this would not only affect their share price, but also their ability to repay their bonds and bank loans.

Risks for financial institutions

A carbon bubble shock could have a large impact on institutional investors. Many pension funds have invested a considerable part of their assets in listed equities, using the main stock exchange indices as benchmarks. The weight of oil, gas and coal mining firms in the London Stock Exchange is more than 20%, compared to approximately 11% in the S&P 500 index for US equities. In other stock exchanges, such as Paris, fossil fuel companies account for less than 10% of market capitalisation. [13, 14] Thus, the exposure to carbon bubble risks of an equity portfolio that uses a benchmark index depends on the index that it uses. The Asset Owners Disclosure Project, a research and advocacy group, recently found in a survey that only 5% of the world's largest investment funds were managing climate risk in what it considers to be a responsible manner. [15]

In January 2012, Climate Change Capital, an asset management firm, and several others warned of the risks for institutional investors in a letter to Mervyn King, governor of the Bank of England, which is responsible for addressing systemic risks to the UK financial system. The letter referred specifically to the high-carbon assets listed on the London Stock Exchange and the potential risks to financial stability resulting from the investments of UK pension funds and other institutional investors in these high-carbon companies. King replied that these issues deserve further evaluation and would be discussed in meetings with market participants [16, 17]. Subsequently, in the European Parliament, questions that also referred specifically to risks for pension funds and other institutional investors resulting from high-carbon investments were put to the European Commissioner for Economic and Monetary Affairs, Olli Rehn. He answered in May 2012 that there was hardly a systemic risk because supervisors were closely monitoring the overall capital position of banks [18, 19]. It seems as if the questions had not been properly understood or the potential systemic importance of financial institutions other than banks had not been fully grasped.

Mercer, an advisory firm, found that the traditional approach used by institutional investors to strategically allocate their assets over different classes, such as developed market equities, government bonds and real estate, is not suitable for taking into account the potential risks of the carbon bubble and climate change. The reason is that these risks affect different asset classes at the same time. Moreover, risks differ considerably between investments within a single asset class, such as low-carbon and high-carbon listed equities. Investors would be better able to manage these risks by shifting into investments that can adapt to a low-carbon economy, including real estate and infrastructure [20]. However, the different scenarios outlined by Mercer have very different implications for investment portfolios. Most importantly, strong climate action and climate breakdown cause losses on very different types of investments.

The Institutional Investors Group on Climate Change (IIGCC), a group of over 80 European investors, has therefore called on policy-makers to adopt an integrated climate and energy framework, agree on binding greenhouse gas emissions limits, and provide long-term policy

certainty. This would help to manage carbon bubble risks and mobilise investments in renewable energy and energy efficiency [21]. Thus, many institutional investors argue that it is up to governments to adopt policies that make green investments more financially attractive.

Some investors have already begun to withdraw from fossil fuel businesses. Norway's sovereign wealth fund, which owns shares in several large mining companies, is likely to divest from coal mining companies [22]. The Norwegian private pension and insurance firm Storebrand announced its withdrawal from coal and oil sand firms, because these businesses would lose much of their value under a two degrees scenario [23]. In the US, five colleges and universities have divested from oil and gas companies because of concerns about climate change and several cities and religious groups have committed to do so [24].

Some argue that institutional investors should avoid risks unique to fossil fuels, notably coal, by actively selecting their equity portfolio to exclude fossil fuel companies rather than using a standard benchmark index. Alternative investments with comparable financial characteristics would include emerging market equities, renewable energy and energy infrastructure [25]. Some investors are also actively investing in environmentally friendly projects, for example through green bonds. This is a swiftly emerging type of bond issued by development institutions or energy companies designated for the financing of renewable energy and other green investments. Investors in green bonds include the pension funds AP Fonden 2 and AP Fonden 4 from Sweden and ABP from the Netherlands, which are also included in this report [26].

One study has attempted to estimate the potential impact of the carbon bubble on Canada. [27] It turned out to be difficult to determine the exposure of Canadian pension funds because of a lack of data. Some data were available for the Canadian Pension Plan, which is large in absolute terms, with pension assets of approximately CAD 180 billion, but covers less than 10% of the Canadian pension sector. The share of fossil fuel companies and pipelines in the domestic equity portfolio of this fund is over 20% and thus very large. The share of foreign equities is smaller; the total equity exposure to oil, gas and coal companies was estimated at 3% of total assets. Another study, focusing on investors that are most likely to divest from high-carbon assets for ethical reasons, calculated that US universities have 2% fossil fuel investments in their endowment funds and UK universities (mainly Oxford and Cambridge) have 4% [28].

In a study with a somewhat different focus, the UK-based Institute and Faculty of Actuaries analysed the potential effects of resource constraints on institutional investors [29]. These constraints include finite oil reserves as well as metal and water sources. Thus, the study does not consider stranded assets, yet it illustrates that the effects of risks that are not properly managed due to large economic and environmental transitions can be severe. In one of the most negative scenarios, which assumed that neither politics nor markets would take resource problems seriously, the economy would eventually be seriously harmed and the funding status of pension funds would quickly deteriorate. Janez Potočnik, European Commissioner for the Environment, noted that resource efficiency should be better integrated into investment decisions by making it more prominent in reporting, risk assessment, and the fiduciary duty of institutional investors (to invest in the best interest of their clients) [30]. This contrasts with the above-mentioned of statement of Commissioner Rehn, who did not see a need for such initiatives.

A report focusing on large commercial banks notes that analysts from investment banks, such as Citibank and Goldman Sachs, warn that coal mining involves large regulatory risks. The study shows that, at the same time, these banks are large providers of credit and underwriters of share and bond issues of coal mining companies. Deutsche Bank, RBS and BNP Paribas are found to be among the global top 10 coal mining banks. The report notes that coal mining requires high capital investments that depend on external financing and the services of these banks are key to those investments [31].

Unlike institutional investors, initiatives by banks themselves regarding carbon bubble risks are rather limited. Rabobank, one of the largest EU banks, stands out with a blanket ban on lending for oil sands [32]. A report by the International Institute for Sustainable Development argues that climate change, including exposures of banks to businesses causing large greenhouse gas emissions, could be an emerging source of systemic

risk. However, it notes that this has not been taken into account in the regulatory response to systemic risk by the Basel Committee on Banking Supervision [33].

Transparency and reporting

Various initiatives aim to improve the management of carbon bubble risks by promoting transparency and reporting regarding these risks. Reporting of greenhouse gas emissions by large non-financial companies has progressed over the past decade, stimulated by projects like the Carbon Disclosure Project (CDP). Reporting by financial institutions on the emissions of their investment portfolio is much less developed. Similar to the CDP, the Asset Owners Disclosure Project (AODP) is currently stimulating institutional investors to report on how they address climate risks [34].

The Finance Initiative of the United Nations Environmental Programme (UNEP-FI), a broader initiative targeting financial institutions, also calls for enhanced reporting on greenhouse gas emissions. UNEP-FI notes that emissions will increasingly be regulated and argues that the current lack of ambitious climate policies will probably lead to more sudden and radical interventions in the future, because greenhouse gas concentrations will have increased further [35]. The Finance Initiative promotes the Greenhouse Gas Protocol, an international accounting tool to measure emissions, developed in partnership between the World Resources Institute (WRI) and the World Business Council for Sustainable Development (WBCSD). This protocol distinguishes scope 1 emissions generated by a company itself, scope 2 emissions from energy consumed by a company, and scope 3 emissions that are an indirect consequence of a company's activities. For institutional investors, the largest part of greenhouse gas emissions is associated with their investments, which fall under scope 3. UNEP-FI and the Greenhouse Gas Protocol are currently developing guidance for scope 3 reporting by the financial sector [36].

The 2 Degrees Investing Initiative, a multi-stakeholder think-tank based in Paris, calls for mandatory disclosure on carbon risks by financial as well as non-financial companies. It highlights the need for longer-term investment horizons and for reducing exposures to carbon risks. The 2 Degrees Investing Initiative emphasises that the required data and methods to assess financed emissions in a broad range of investment classes are already available. To enhance risk management by financial institutions, the initiative supports further standardisation of reporting on greenhouse gas emissions [37].

Legal reporting frameworks in France and the UK require reporting on greenhouse gas emissions from 2014 onwards. In France, social and environmental reporting is mandatory for publicly listed and large unlisted companies. The new Grenelle II standard prescribes that this must include reporting on greenhouse gas emissions. In the UK, carbon reporting in annual reports is mandatory for firms listed on the London Stock Exchange. As these mandatory reporting frameworks apply to companies in all sectors, they are focused on direct emissions. At the EU level, on 16 April 2013 the Commission proposed a directive establishing a legal obligation for companies to disclose environmental, social and diversity information (COM(2013) 207) [38]. The proposal would add to the new Accounting Directive (2013/34/EU) a requirement to report on environmental matters, including related company policies, results, risks and risk management. Companies can rely on existing frameworks for compiling and presenting this information. However, the current proposal does not refer in any way to greenhouse gas emissions or climate change, nor does it give special consideration to reporting by financial institutions.

Exposure of EU pension funds to carbon bubble risks

Selection of pension funds

For the analysis of pension funds' exposure to high-carbon assets, 23 pension funds were selected for an in-depth investment analysis. Pension funds are often not transparent about their investments. For the funds that do publish more detailed data in the majority of cases only reveal their investments in listed equities. Very little information is available on specific investments in corporate bonds and other investment instruments.

The top 23 pension funds in the European Union (EU) for which data on their security holdings is available, were selected based on their total assets in 2012. The analysis uses total assets because unit-linked policies and fixed non-financial assets do not play a sizeable role for the pension funds. Information on their equity holdings can either be accessed through the funds' own publications or through financial databases. While selecting the largest EU pension funds results in a more limited geographical coverage than selecting a small number of funds per member state, it does cover a larger share of the total assets of EU pension funds. An assessment at member state level would also be hampered by the limited sample of pension funds for which relevant data can be found in some member states.

Table 1 lists the 23 major European pension funds for which sufficient information could be found, listed by their total assets at the end of December 2012 (unless otherwise noted). This does not constitute a ranking of the top EU pension funds overall.

Sweden is represented by six funds, the UK by five and the Netherlands by four. Finland follows with three pension funds and Denmark with two. France, Spain and Belgium have one pension fund each. Other EU countries are home to pension funds holding significant assets as well. However, they could not be considered here as no detailed data on their equity investments are available in the Thomson ONE database. For the Netherlands, a balance was sought between pension funds for whole sectors and individual firms. Important pension funds that were not considered in the analysis due to data limitations are (with country and total assets as of 31 December 2012):

- Bayerische Versorgungskammer (Germany, € 55.4 bn), a group of pension funds for different professions, of which the largest are doctors (€ 17.9 bn) and employees of municipalities (€ 15.2 bn)
- Pensioenfonds van de Metalektro (Netherlands, € 47.0 bn)
- Electricity Supply Pension (UK, € 38.4 bn)
- British Coal Pension Schemes (UK, € 25.9 bn)
- BVV Pensionskasse (Germany, € 23.9 bn)
- Railways Pensions (UK, € 23.3 bn)
- Pension funds of Lloyds TSB Group, Royal Bank of Scotland Group, Barclays Bank UK and HSBC Bank (UK, ranging from € 22 bn to € 28 bn)
- National Pensions Reserve (Ireland, € 15.2 bn as of 31 March 2012)

General asset distribution

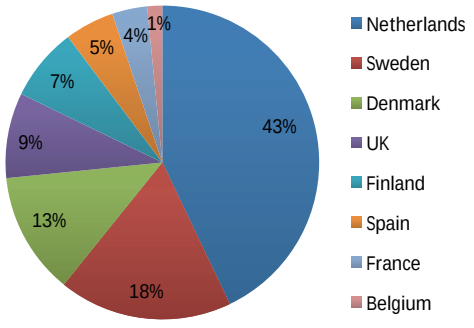
The value of the total assets of the pension funds under analysis was taken from the latest available annual reports, in most cases dated December 2012, and converted to Euros where applicable. They held assets with a total value of € 1,237.6 billion at the end of 2012. *Figure 1* shows how the assets are distributed over 8 EU countries.

Table 1: Analysis of pension funds by total assets [39]

Pension fund	Country	Total assets as of 31 Dec 2012 (€ billion)	Source (see references)
ABP	Netherlands	314.9	[40]
PFZW	Netherlands	150.9	[41]
ATP	Denmark	106.4	[42]
Alecta	Sweden	64.9	[43]
Fondo de Reserva	Spain	63.0	[44]
PFA Pension	Denmark	49.6	[45]
FRR	France	44.9	[46]
AMF Pension	Sweden	44.0	[47]
bpfBouw	Netherlands	43.4	[48]
Universities Superannuation Scheme (USS)*	UK	41.0	[49]
Keva	Finland	34.4	[50]
Varma	Finland	30.3	[51]
AP Fonden 3	Sweden	30.2	[52]
Ilmarinen	Finland	28.8	[53]
AP Fonden 2	Sweden	28.2	[54]
AP Fonden 1	Sweden	27.2	[55]
AP Fonden 4	Sweden	26.8	[56]
Royal Dutch Shell Pension Fund	Netherlands	21.9	[57]
BP Pension Fund	UK	20.7	[58]
British Airways Pensions*	UK	20.3	[59]
Zilverfonds/ Fonds de vieillissement	Belgium	19.2	[60]
British Steel Pensions**	UK	15.4	[61]
BAE Systems Pension Scheme*	UK	11.4	[62]
Total		**1,237.6**	

** as of 31 March 2012 ** as of 31 March 2013*

Figure 1: Asset distribution of analysed pension funds by country of origin

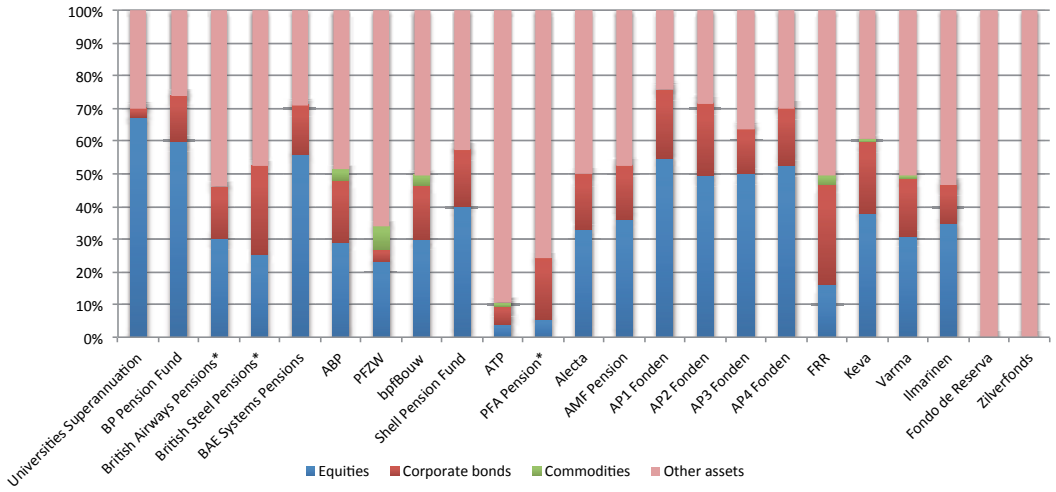


Source: 2012 annual reports of the pension funds.

Typical instruments used by pension funds to invest their assets include listed equities, bonds (government, mortgage and corporate bonds), real estate and infrastructure, as well as alternative investments, such as derivatives or private equity.

Figure 2 depicts the share of listed and unlisted equity and corporate bonds in the overall investment portfolios of the analysed pension funds. The pension funds are grouped by country and ordered by size of the national pension sector. The assets of the state pension funds from Spain and Belgium stand out as these two funds exclusively invest in government bonds

Figure 2: Distribution of investments in shares and corporate bonds



** no data on commodity investments available*

Source: 2012 annual reports of the pension funds

The distribution of investments over different asset classes differs considerably between the different pension funds. The share of investments in equities ranges between 0% and 67%, while the share of corporate bond holdings varies between 0% and 31% and that of commodity investments between 0% and 7%. Across the 23 pension funds, the weighted average asset proportions are 27% for equities, and 14% for corporate bonds and 2% for commodities. Other assets include government bonds, real estate and private equity.

Investments in high-carbon equities, bonds and commodities

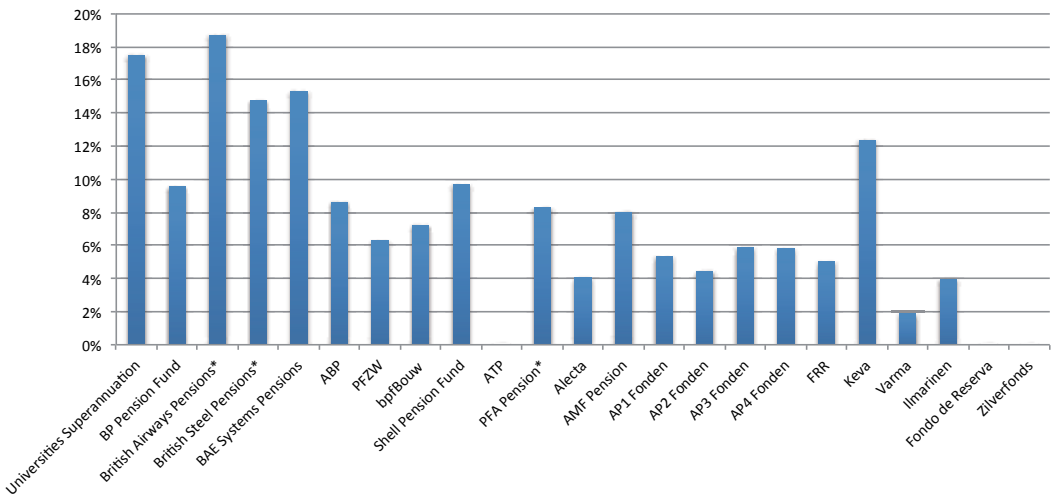
The investments of the 23 selected pensions funds in listed shares of oil, gas and coal producers were analysed on the basis of the reported shareholdings of the pension funds. A list of oil, gas and coal mining companies worldwide was drawn up from financial databases based on common industry classifications. This includes companies active in oil and gas production and in coal mining. The high-carbon companies were mainly identified through filtering financial databases across mid- and micro-industry classifications. This was complemented by manually adding coal mining companies with diverse mining activities to the list. The identified companies were matched with the investments of the pension funds.

The value of these shareholdings was calculated and multiplied by a correction factor to account for other business activities besides the production of fossil fuels. The correction factor is based on the revenue from different business segments or similar information. Such a correction applies in particular to mining companies, as these have more often a diversified range of mining activities besides coal mining. So while a coal mining company like U.S.-based Arch Coal was assigned a 100% share of high-carbon activities, this share stands at 31% for Indonesian conglomerate Astra International or 39% for diversified mining company Exxaro Resources. For oil and gas companies in most cases the full amount can be applied as the majority of these companies focus exclusively on these high-carbon business activities.

Where data from financial databases has been used, it must be taken into account that coverage of equity holdings is often limited. For this research, on average 53% of holdings are covered, but in some cases only 10%. For the purpose of this analysis it is assumed that the covered holdings are representative of the overall portfolios of the pension funds.

Figure 3 illustrates the share of high-carbon equities in the total holdings of the pension funds in listed equities.

Figure 3: Share of high-carbon equities in total equity holdings



** no data on commodity investments available*

Note: AMF Pension states in its annual report that 5% of listed equities are in oil and gas and 9% in basic materials. These percentages are higher than own estimations based on limited coverage in Thomson ONE, thus an estimate of 5% oil and gas and 3% coal, as a key category under basic materials, was used for AMF Pension.

Sources: 2012 annual reports of the analysed pension funds; Thomson ONE Database, "Shareholdings", Thomson ONE Database, viewed October 2013; AMF, "2012 AMF Årsredovisning", AMF, February 2013; bpfBouw, "Aandelenportfeuille per 30 June 2013", bpfBouw, 30 June 2013; FRR, "Report Annuel 2012", FRR, 12 April 2013; Pensioenfonds Zorg en Welzijn (PFZW), "(In)directe beleggingen van PFZW in beursgenoteerde aandelen", PFZW, 31 December 2012; own calculations.

The actual value of these shareholdings adds up to an estimated € 29 billion across the 23 pension funds. The share of holdings in high-carbon companies varies widely, ranging from 0% to 19% of the total equity investments across these pension funds. On average, high-carbon equities account for an estimated 7% of their shareholdings and for an estimated 2.3% of their total assets. The high-carbon share of equities in the MSCI World Index is, at 9.4%, somewhat larger.

Spanish Fondo de Reserva and Belgian Zilverfonds hold no equity investments. Danish pension fund ATP is also an exception as it holds large investments in bonds, especially government bonds, but only a very small amount of equities. For these funds no investments in high-carbon companies could be identified, however, this finding is based on listed equity holdings documentation that covers only about 30% of the total. There may thus be some relevant investments for which no coverage was available. Finnish pension fund Varma was found to only have a very small share of high-carbon equity holdings, while investing large amounts in predominantly Finnish companies active in telecommunication, construction, financial and other business areas. However, as investments in mutual funds could not be analysed, the share of high-carbon investments may have been underestimated.

Apart from equities, pension funds are also exposed to corporate bonds issued by fossil fuel producers. In some cases, pension funds do not break down their bond holdings in enough detail to obtain the exact value of their corporate bond holdings (e.g. if holdings in index-linked bonds are not broken down into government and corporate bond holdings). In those cases an estimate based on other data in the annual report referring to the role of corporate bonds is made. Pension funds are generally less transparent on their bond holdings than on their shareholdings, with only few of them publishing details. For reasons of consistency it is assumed for all the pension funds that the high-carbon share of bond holdings is equal to that of the leading benchmark index, the PIMCO Global Advantage Bond Index.

At the end of 2012, this share was 8.4% of the total corporate bond investments, including financial and non-financial issuers [63]. This yields an estimated value for the investments of the pension funds in corporate bonds of high-carbon companies of € 15 billion.

As a weighted average, high carbon corporate bonds account for an estimated 1.2% of the total assets of the analysed pension funds.

Some pension funds are also exposed to high-carbon assets through investments in commodities. They often consider this a separate asset class or sub-class that may help to diversify market risks. Commodity investments include a considerable share of fossil fuels, in addition to precious and industrial metals or agricultural goods. These commodity positions are usually obtained indirectly through investments in derivatives, including, for example, futures, swaps and forward contracts. They are often used to improve investment management and to hedge risks. Not all pension funds provide detailed information on commodity investments and/or different types of derivatives.

For those providing information, the share of these investments differs considerably. The following list gives a brief description of investments in commodities, including in fossil fuels:

- Dutch PFZW allocated 7.2% of its investments to commodities [64]. Approximately 80% of these investments, and thus 5-6% of total assets, are positions in oil [65].
- For Dutch ABP, the net asset value of investments in commodities was € 10.2 billion or about 3.2% of the investment portfolio in 2012 [66]. The largest part of these investments is related to oil and gas [67].
- For Dutch pension fund bpfBouw, the value of commodity investments was € 1.4 billion or 3.2% of its total investment portfolio [68]. The composition of these commodity investments is not specified.
- Shell's Dutch pension fund did not invest in commodities in 2012, but mentioned the possibility of doing so in the future [69].
- The French FRR held investments in commodities, excluding agricultural products, accounting for 3% of its total investment portfolio in 2012 [70].
- The Finnish pension fund Keva invested 0.6% of its total portfolio in commodities in 2012 [71].
- Another pension fund from Finland, Varma, invested about 1% of its portfolio in commodities [72].
- Danish pension fund ATP reports commodity investments in an oil bond portfolio of DKK 7.6 billion (€ 1.0 billion) [73]. Oil bonds are government bonds that are issued in countries with government-controlled oil pricing structures. The government issues oil bonds to these companies to compensate them for losses incurred when restrictions prevent them from raising prices in line with market trends. The oil companies can sell these bonds like any other bond.
- Swedish national pension funds are not allowed to invest in commodities or commodity-based financial instruments [74].
- The UK pension funds analysed mainly use derivatives to manage interest, currency and credit risks and not to take commodity positions. Although some funds have partly unspecified alternative investments, the exposure of British pension funds to commodities may be insignificant [75].

Using Standard & Poor's GSCI commodity index as a benchmark, it can be assumed that on average approximately 70% of the pension funds' commodity investments involve fossil fuels (unless specified otherwise) [76]. Three of the four Dutch pension funds have large commodity investments. Due to the assumed risk diversification, Dutch regulations regarding defined benefit pension schemes give favourable treatment to commodity investments, which it considers as a separate asset sub-class, by reducing reserve requirements. Note that the reported market value of commodity derivatives may not always fully reflect the size of the exposure. For example, the market value of Ilmarinen's commodity investments was minus € 1.1 million as of December 2012. This suggests that the fund entered into derivatives contracts with small initial market value but that significant upside and downside risks resulted in a negative market value at the balance sheet date. On the basis of the available data, it is estimated that high-carbon commodity investments constitute 1.5% of the 23 pension funds' total assets.

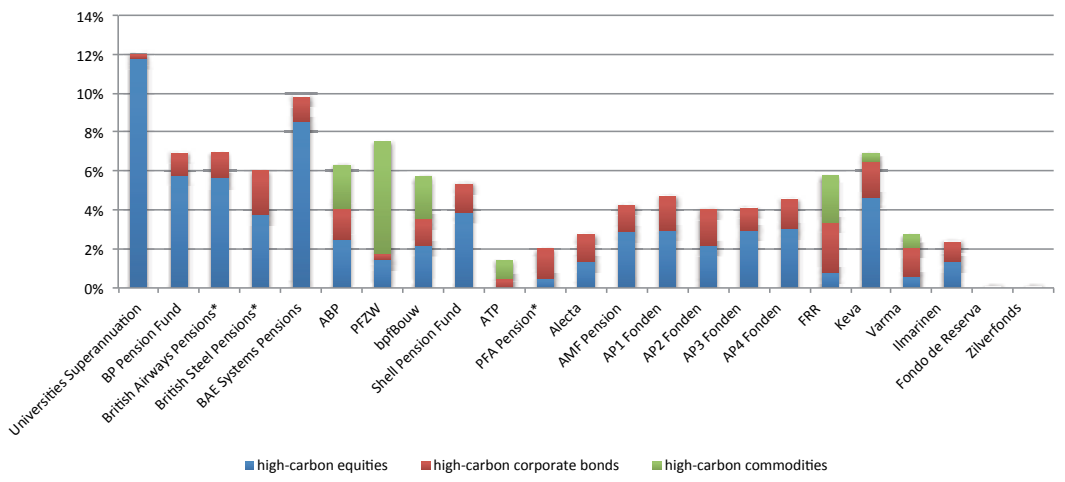
Combined exposure to high-carbon assets

Figure 4 shows the combined distribution of the share of high-carbon equities, corporate bonds and commodities in the total assets of the pension funds. The Universities Superannuation Scheme, BAE Systems Pension Scheme and British Airways Pension Fund, all based in the UK, seem most exposed to the carbon bubble. This

is followed by the BP Pension Fund, also from the UK, PFZW from the Netherlands, and Finnish fund Keva. Based on this analysis, Fondo de Reserva from Spain, Zilverfonds from Belgium, Danish pension funds ATP and PFA and Varma from Finland face the lowest risk from high-carbon investments.

The high exposure of the Universities Superannuation Scheme (USS) is remarkable, considering that it warned itself about the risks of climate change for investors in a 2001 report. USS is also a founder of the Institutional Investors Group on Climate Change (IIGCC). Responding to an April 2013 letter about the carbon bubble, the fund explains: *"USS's investment policy must be consistent with our legal responsibility under trust law. This requires USS to have maximising returns for the scheme's beneficiaries as its primary objective. As part of this, USS is obliged to invest in a wide spectrum of companies and, unlike individual investors, the fund is not able to make ethical choices to screen out certain investments.* [77]*"* However, this does not explain why the USS's exposure is apparently much higher than that of other pension funds, including those from the UK, given that they operate on the basis of the same primary objective and are subject to the same legal requirements.

Figure 4: Share of high-carbon investments in total assets



** no data on commodity investments available*

Sources: 2012 annual reports of the analysed pension funds; Thomson ONE Database, "Shareholdings", Thomson ONE Database, viewed October 2013; AMF, "2012 AMF Årsredovisning", AMF, February 2013; ATP Group, "Annual Report 2012", ATP Group, 30 January 2013 bpfBouw, "Aandelenportfeuille per 30 June 2013", bpfBouw, 30 June 2013; FRR, "Report Annuel 2012", FRR, 12 April 2013; Pensioenfonds Zorg en Welzijn (PFZW), "(In)directe beleggingen van PFZW in beursgenoteerde aandelen", PFZW, 31 December 2012; own calculations.

Figure 5: Estimated share of high-carbon assets

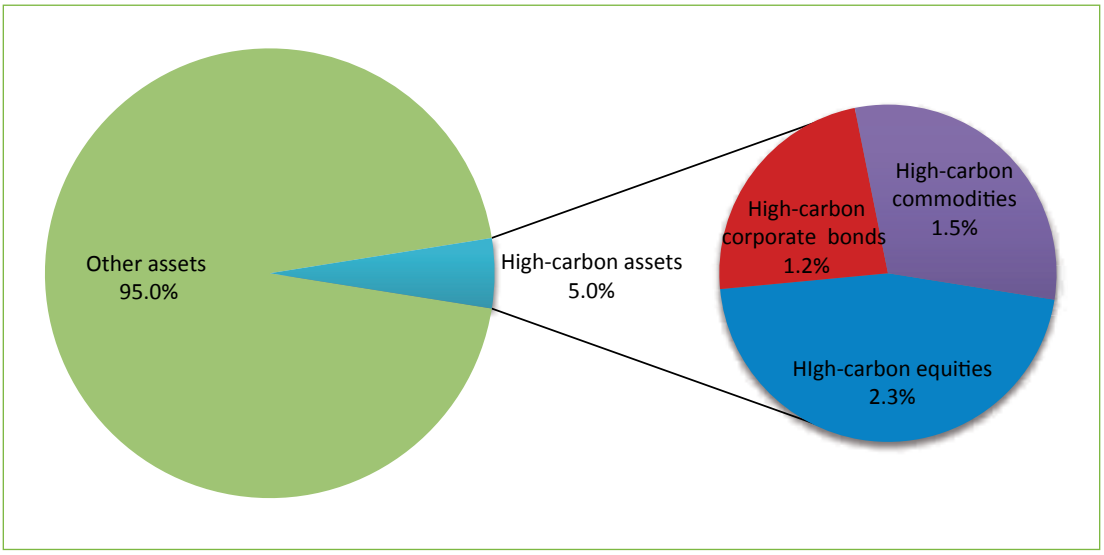


Figure 5 illustrates the estimated share of high-carbon assets across the 23 pension funds.
The contribution to total assets of high-carbon equities, corporate bonds and commodities holdings varies between 0% and 12%, with a weighted average of 5%. The estimated value of all high-carbon investments of the analysed pension funds is € 62 billion.

Extrapolation to the EU pension sector

By assessing the relative share of high-carbon investments of the analysed pension funds in relation to their total assets, the findings can be extrapolated across the relevant sectors in the EU to give an indication of the exposure of the sectors as a whole to the carbon bubble.

There is a remarkable lack of comprehensive data on the value of the assets of pension funds in the European Union as a whole. The European Central Bank presents data on Eurozone members, which does not cover some of the other EU member states with large pension fund assets. The data provided by the European Insurance and Occupational Pensions Authority (EIOPA) shows total pension fund assets in the EU of € 4,610 billion in 2011. While this database aims to cover all EU member states, data for several countries are not available or incomplete [78]. Auditing company PriceWaterhouseCoopers estimates that in 2011, the top 1,000 pension funds in the European Union collectively held more than € 5,100 billion in assets [79]. Compared with the EIOPA data, it seems reasonable to use this estimate of at least € 5,100 billion of pension fund assets in the EU in 2012. The 23 analysed funds, which have total assets of € 1,238 billion, therefore represent 24.3% of the estimated total assets of European Pension funds.

Table 2: Extrapolation of findings to the EU pension sector

	Average % of total assets based on analysis of 23 large EU pension funds	Exposure of EU pension sector based on € 5,100 bn total assets (€ bn)
High-carbon equities	2.3%	118
High-carbon corporate bonds	1.2%	60
High-carbon commodities	1.5%	78
Total high-carbon investments	**5.0%**	**256**

Average investments of 28% in equities and 2.3% in high-carbon equities result in a total estimated shareholding value of € 1,423 billion and a value for high-carbon shareholdings of € 118 billion. For corporate bond holdings, the analysis results in an estimated total value of € 714 billion and high-carbon corporate bond investments of € 60 billion. Furthermore, average commodity investments account for an estimated € 78 billion. Based on these assumptions, high-carbon assets held by European Union pension funds had an estimated value of € 256 billion at the end of 2012 (see *Table 2*).

Using an alternative approach, the high-carbon assets of the pension funds were first extrapolated on a national level, based on the national pension fund assets and using weighted average exposures to high-carbon shares and bonds across the analysed domestic pension funds. At the national level, high-carbon investments range up to 8% of total assets for equities (in the UK), 3% for corporate bonds (in France), and 3% for commodities (in the Netherlands). The total estimated high-carbon investments for the eight countries in the analysis are approximately € 250 billion. The countries for which pension funds were included in the analysis account for 73% of all EU pension fund assets [80]. Scaling up to the European level thus results in estimated high-carbon shareholdings of € 330 billion or 6.4% of the total assets of all EU pension funds. This method results in a higher estimate, mainly because of the UK's large pension sector with relatively high equity exposures to fossil fuel firms.

Extrapolating the national findings to the European level, high-carbon assets held by European Union pension funds had an estimated value of € 256 billion to € 330 billion at the end of 2012. As this is based on more than 20% of total pension fund assets in the European Union, it should provide a reasonably reliable impression of the actual exposure of pension funds to high-carbon companies. It is a conservative estimate, considering that, for example, exposure through commodity investments is not considered in the calculation. For three countries the analysis was based on only one pension fund, of which two only invest in government bonds.

Exposure of EU banks and insurance companies to carbon bubble risks

Selection of banks

For the in-depth investment analysis of the banking sector's exposure to high-carbon assets, the top 20 banks headquartered in an EU country were selected. They were chosen based on their total assets in 2012 as reported in their annual reports. For banks with a significant share of activities in the insurance sector the analysis is based on banking activities and excludes insurance-related assets as far as data availability allows.

While using the top 20 banks results in a more limited geographical coverage than selecting a small number of banks per member state, a larger share of the total assets of the EU banks is covered using this approach. This makes extrapolation across the EU as a whole more reliable.

The value of the total assets of the analysed banks was taken from the latest available annual reports, in all cases dated end of December 2012, and converted to Euros where applicable.

Table 3 lists the largest European banks and banking groups measured by total assets at the end of December 2012.

Table 3: Top 20 European banks and banking groups by total assets (as of 31 Dec. 2012) [81]

Bank / banking group	Country	Total assets (€ billion)	Source (see references)
HSBC Holdings	UK	2,037	[82]
Deutsche Bank	Germany	2,012	[83]
BNP Paribas	France	1,907	[84]
Barclays	UK	1,822	[85]
Credit Agricole*	France	1,594	[86]
Royal Bank of Scotland	UK	1,569	[87]
Santander Group	Spain	1,270	[88]
Société Générale	France	1,251	[89]
Groupe BPCE	France	1,148	[90]
Lloyds Banking Group	UK	1,130	[91]
UniCredit Group	Italy	927	[92]
ING Bank*	Netherlands	836	[93]
Rabobank Group	Netherlands	752	[94]
Nordea	Sweden	677	[95]
BBVA	Spain	638	[96]
Commerzbank	Germany	636	[97]
Intesa Sanpaolo*	Italy	593	[98]
Standard Chartered	UK	482	[99]
Danske Bank*	Denmark	435	[100]
DZ Bank*	Germany	341	[101]
Total		**22,056**	

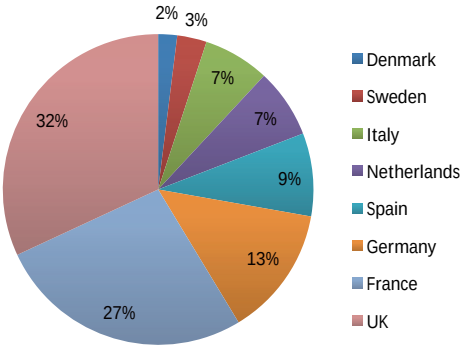
** excluding assets relating to insurance activities*

Five of the top 20 banks are based in the UK, with HSBC being the largest. Deutsche Bank, one of three German banks on the list, takes second place. Four French banks and two banks from Spain, the Netherlands and Italy, respectively, are represented among the leading European banks. Sweden and Denmark have one bank each on the list.

General asset distribution

The analysed banks are headquartered in eight European Union member states and held assets with a total value of € 22,056 billion at the end of 2012. Among them, the UK banks, with 32%, account with for about one third of the assets, followed by the French banks with 27% and German banks with 14%. The Spanish banks take a 9% share, followed by the Netherlands and Italy with 7% each. The Swedish and Danish banks make up the remaining 5% (see *Figure 6*).

Figure 6: Asset distribution of analysed banks by home country



Source: 2012 annual reports of the banks

Typical asset classes of commercial banks include loans and advances to banks and customers (including corporate, public and retail customers), "held-for-trading" assets, "available-for-sale" assets, "held-to-maturity" investments, financial assets at fair value through profit or loss and hedging derivatives. For this analysis, corporate loans and asset classes including corporate bonds and equities held by banks themselves are of particular interest as these expose the banks to high-carbon companies. For six of the banks no details on the share of government bonds was available. As the share of government bonds in total assets varies considerably from bank to bank, it is not possible to provide reasonable estimates for this share and these banks could thus not be considered in the analysis of corporate bond holdings.

Figure 7 depicts the share of corporate bonds, equities and corporate loans in the total assets of the banks.

The distribution of the shares of different asset classes in the total assets of the analysed banks differs considerably. The share of investments in equities differs between 0.1% and 9.4%, while the share of corporate bond holdings varies between 0.2% and 2.9% (for the 14 banks that could be analysed for this class, partly based on estimates). Overall holdings in debt securities, including corporate bonds, government bonds and other fixed-interest securities, vary between 8% and 27% of total assets. The share of corporate loans in total assets varies between 8% and 37%. Other assets account for roughly 50% to 80% of total assets and include real estate financing, loans to public institutions, interbank financing, and derivatives.

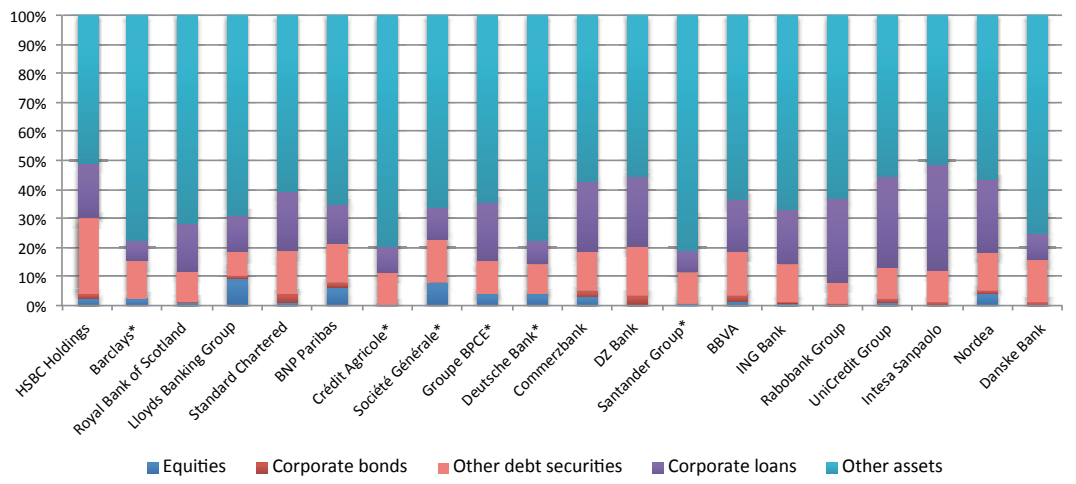
Across the banks, the weighted average of assets invested in equities is 3.0%, while 1.1% of assets are invested in corporate bonds and 17.8% of assets are accounted for by corporate loans. The exposure of the banks to companies holding high-carbon assets, i.e. oil, gas and coal producing companies, was assessed on the basis of two different indicators: outstanding corporate loans to high-carbon companies on the one hand, and investments in equities and debt securities on the other.

Exposures to high-carbon assets in corporate loan portfolio

Calculation of corporate loan exposures

The financial statements of the banks were analysed to extract the total value of all outstanding corporate loans provided by the banks. Only loans to non-banking and non-financial corporates have been considered, thus excluding banks, insurance companies and other financial institutions. The next step was to analyse in detail outstanding loans (as of 1 January 2013) which involve the participation of one or more of the analysed banks as reported in the financial database Thomson ONE Banker. The following industry sectors, which are directly related to the production of oil, gas and coal, were used as criteria in the search:

Figure 7: Shares of different asset classes in total assets



** no details on share of corporate bond holdings in total debt security investments available*

Note: debt securities include debt securities issued by governments and other public bodies, treasury bills, bonds issued by financial institutions and corporate bonds (where it was not possible to single out corporate bonds); corporate bonds include bonds issued by non-financial corporates.

Source: 2012 annual reports of the banks; own calculations.

- crude petroleum and natural gas extraction;
- natural gas liquid extraction;
- drilling oil and gas wells;
- petroleum refineries (excl. petrochemicals);
- bituminous coal and lignite surface mining;
- bituminous coal underground mining.

These categories also include some activities which are directly linked to the production of fossil fuels, including for example large-scale oil and gas pipeline projects, oil tanker construction projects or the construction of LNG-terminals. As the categorisation is not always correct, companies that have obtained loans were screened for potentially erroneous categorisations that had to be removed. Next, a correction factor was applied to companies with substantial business activities in other sectors. In some cases this had to be based on estimates as private companies in particular tend not to publish detailed figures on their asset distributions.

Applying these criteria resulted in a list of 823 high-carbon companies that have received one or more syndicated loan(s) involving one or more of the analysed banks. This includes different kinds of facilities provided any time before 1 January 2013 and maturing any time after this date.

Apart from syndicated loans (provided by a banking syndicate), banks also provide bilateral loans to fossil fuel companies. For this type of loan no data are available. This is not seen as a major problem, as bilateral loans are generally much smaller than syndicated loans and large fossil fuel companies seldom use bilateral loans.

Focusing on syndicated loans therefore captures a very significant part of the banks' credit exposure to the fossil fuel sector and allows for an assessment with a reasonable error margin.

The assessment focuses on loans still outstanding at the research date (i.e. on the bank's balance sheet). This way a reliable estimate can be made of the top banks' exposure to producers of oil, gas and coal. This exposure is expressed in value terms, but also as a percentage of the banks' total exposure to corporates and as a percentage of their total assets. Using these percentages, the findings can be extrapolated to the whole EU banking sector.

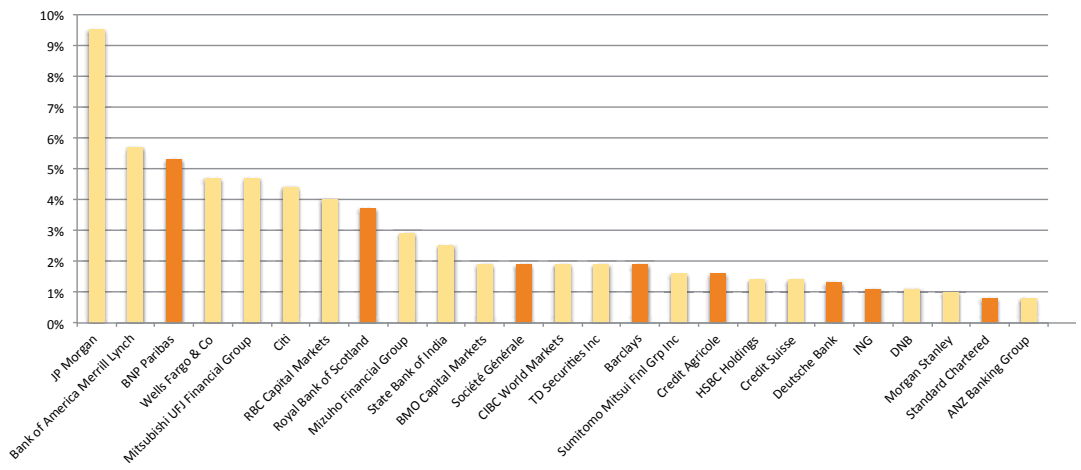
Top bookrunners of syndicated loans

In order to assess the involvement of the large European banks in loans issued to high-carbon companies, a ranking of top bookrunners provides an interesting first insight. The ranking was created based on documentation in Thomson ONE financial databases on the banks' role as bookrunners for syndicated loans to high-carbon companies; that is, as the lead arranger who also provides a large share of the actual lending value. It is broadly based on the value of loans to companies active in the aforementioned high-carbon sectors which were issued up to 31 December 2012 and mature after that date [102]. Figure 8 shows the top 25 international bookrunners for more than 2,000 loans with a total value of € 1,063 billion. Eight of Europe's largest banks are among the top 25: BNP Paribas takes third place with 5.3% behind two U.S. banks at the top, followed by Royal Bank of Scotland in eighth place with 3.7%. Also Société Générale, Barclays, Crédit Agricole, Deutsche Bank, ING and Standard Chartered are among the top 25.

Total corporate loan exposures

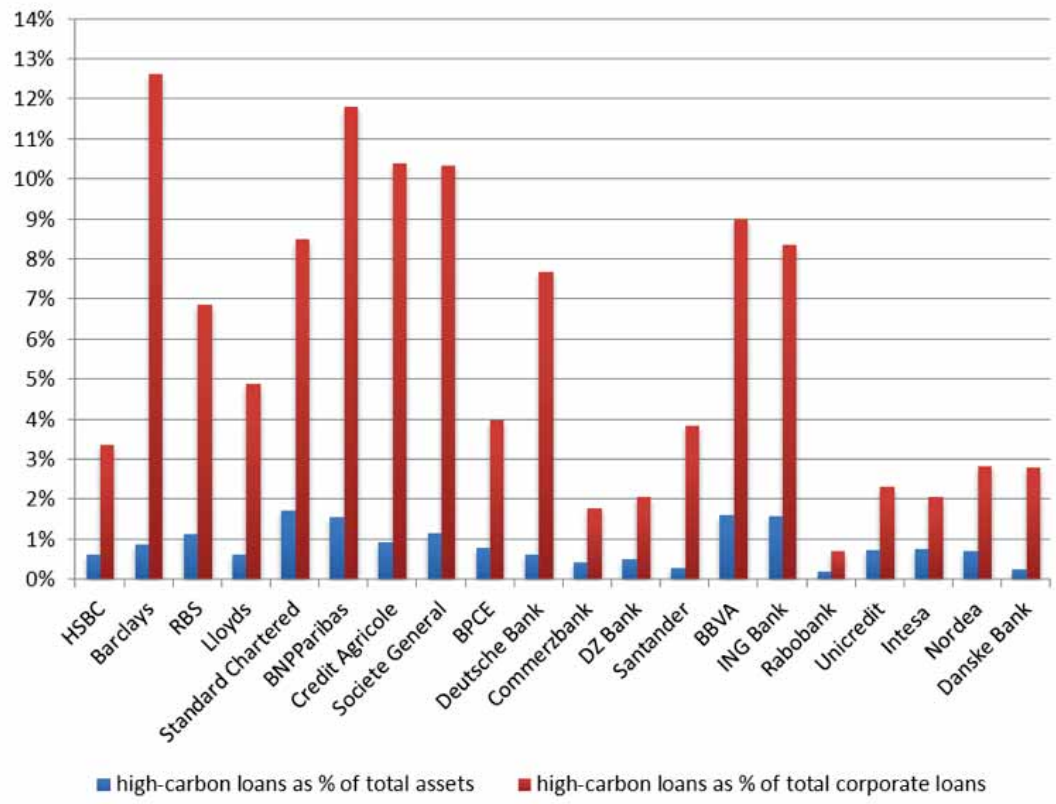
For a more precise analysis, loans to oil, gas and coal mining companies worldwide that were still (partially) outstanding as of 31 December 2012 and which involved one or more of the analysed banks were extracted from the database. The companies were selected based on common industry classifications. After removing companies that had been erroneously classified, 823 companies remained; these were assessed for their relative exposure to high-carbon activities. Where applicable, a correction factor was applied if other business activities existed. For each loan, the share of one or more of the analysed banks in the provision of the loan, depending on their role as bookrunner or common participant, was estimated. Depending on the total years to maturity, the outstanding share as of the end of December 2012 was calculated.

Figure 8: EU banks among top bookrunners for high-carbon loans



Source: Thomson ONE Banker, "Custom ranking", Thomson ONE Database, viewed November 2013; own estimates.

Figure 9: High-carbon share of outstanding corporate loans (as of 31 Dec. 2012)



Source: 2012 annual reports of the banks; Thomson ONE Banker, "Syndicated loans", Thomson ONE Banker, viewed November 2013.

The financing provided to fossil fuel producers in the form of loans can be expressed in value terms, as a percentage of the total corporate loans provided by the bank outstanding as of 31 December 2012, and as a percentage of the total assets of the banks. The total corporate loans outstanding per bank at the date of reporting were taken from their annual financial statements. A complete breakdown of loans by sector (singling out public sector, banks and other financial institutions as recipients of loans) is usually provided in the balance sheet and related notes. In some cases such a breakdown is only available in the credit risk analysis section. The figures provided there differ somewhat from those presented on the balance sheet due to different calculation methods.

Figure 9 illustrates the estimated share of loans to high-carbon companies in total assets as well as the share of loans to high-carbon companies in total outstanding corporate loans provided by the analysed banks at the end of 2012.

The total estimated value of the outstanding loans to high-carbon companies for the 20 banks is € 192.7 billion. The share of outstanding high-carbon loans in the total assets of the banks varies between 0.2% and 1.7%, with a weighted average of 0.9%. When calculating the share of high-carbon loans in the estimated value of overall outstanding corporate loans, this share varies between 1% and 13%, with a weighted average of 7%.

British bank Standard Chartered has the highest share of outstanding loans to carbon-intensive industries with a 1.7% share of total assets. This is almost nine times higher than the exposure of the lowest-scoring bank at 0.2%. BBVA from Spain, Dutch ING Bank and French BNP Paribas also show high levels of exposures to corporate loans, each with a 1.6% share of high-carbon loans. The smallest share of high-carbon loans was held by Dutch Rabobank at 0.20% of total assets and by Danske Bank at 0.26%. However, it must be recalled that the narrow industry classification applied in this analysis could affect the

outcome as, for example, although Rabobank may be participating less in loans to fossil fuel producing companies, it could be involved in loans to downstream companies like leading commodity and oil trader Trafigura.

When looking solely at their share of the corporate loans portfolio, British Barclays as well as BNP Paribas, Crédit Agricole and Société Générale claim the highest percentage. Based on the absolute value of high-carbon loans, BNP Paribas stands out with an estimated € 30 billion outstanding, followed by RBS with € 18 billion, Barclays with €16 billion and Société Générale with € 15 billion.

Breakdown of corporate loan exposures by type and maturity

Loans can be either short-term or long-term in nature. Short-term loans (including trade credits, current accounts, leasing agreements etc.) have a maturity of less than a year. They are mostly used as working capital for day-to-day operations. Short-term debts are often provided by a single commercial bank, which does not ask for substantial guarantees from the company. A long-term loan has a maturity of at least one year, but generally of three to ten years. Long-term corporate loans are particularly useful for financing expansion plans, which only generate rewards after a certain period of time. The proceeds of corporate loans can be used for all a company's activities. Long-term loans are often extended by a loan syndicate, which is a group of banks brought together by one or more arranging banks. The loan syndicate will only undersign the loan agreement if the company can provide certain guarantees that interest and repayments on the loan will be fulfilled.

A revolving credit facility is a specific type of loan that provides a company with the option to take up a loan from a bank (or more often, a banking syndicate) when it urgently requires finance. Revolving credits are often contracted for a five year period and then renewed; but many companies renegotiate their revolving credit facility every year with the same banking syndicate. Amounts, interest rates, fees and participating banks can change slightly every year. As such renegotiations by larger companies are often reported in the financial press, the impression could be given that banks are lending huge sums of money to the same company every year. However, these are essentially only renegotiations of the same facility. A revolving credit facility is hardly ever (fully) called upon for a loan, but if a company experiences financial distress, it is likely to make maximum use of the credit facility, turning it into a risky exposure for the banks involved. The analysis in this report therefore uses the total committed amounts.

Project finance is another specific type of long-term loan. The proceeds can only be used to finance a specific project: a mine, pipeline, an oil rig, a vessel etc. Project finance is often extended by a banking syndicate, like corporate loans. Unlike corporate loans, the repayment of a project finance loan is dependent upon the revenues that a project is expected to generate once it is up and running. To guarantee the payment of interest and repayments as much as possible, the banks usually demand that the revenues of the project must be used first to pay interest and repayment. Only if the revenues are large enough, will the remainder be paid out as dividends to the owner(s) of the project. Banks run a fairly high risk on these loans: if the project is not successful and does not generate (sufficient) revenues, they will not receive interest and repayments (or less than agreed). In that case, the banks do not have the option (or only to a very limited extent) to call upon the owner(s) of the project to pay interest and repayments from the revenues generated by other activities of the owner(s). This is called non-recourse or limited-recourse financing.

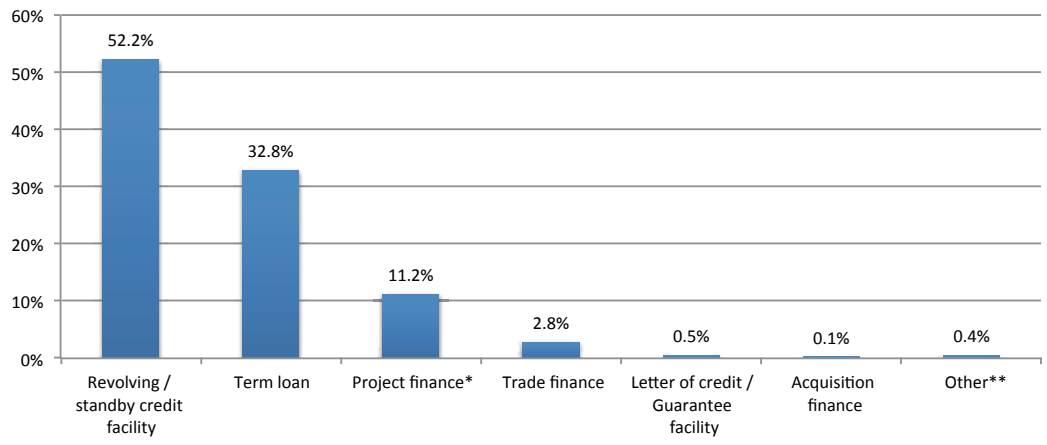
Because banks run a higher risk with a project finance loan, they will carefully evaluate the project in advance and will demand to be closely involved in the day-to-day running of the project. Also, banks will demand a higher interest rate for project financing loans. This makes project financing loans less attractive for most companies planning to develop a project. Project finance is a niche market for financing projects under specific circumstances, e.g. if the project is very large compared to the size of the owner, or if some of the owners of the project do not have cheaper financing options available.

As project finance is not identifiable as a separate category when downloading large amounts of deals from the database, as is the case for this analysis, deals that can be linked to a specific project, for example an oil rig, exploration of a specific gas field or a pipeline, have been manually categorised as project finance. In addition, capital expenditure facilities were added to the category of project finance.

The outstanding amounts of individual deals are calculated based on the share of outstanding years to maturity as of the end of 2012, in relation to the total maturity of the loans. In order to establish the contribution of the individual banks to the analysed corporate loans and revolving credit facilities, estimates are used based on the following rules of thumb: generally it is assumed that 40% of the total amount is committed by bookrunners and 60% by other participants of the syndicate. If, however, the number of bookrunners is (almost) equal to, or higher than, the number of participants, the reverse is used: 60% for the bookrunners and 40% for the arrangers. Thus, if there are, for example, 5 bookrunners and 4 participants and the amount of the loan is € 100, the estimate will be that the bookrunners commit 60% (€ 12 each) and the participants 40% (€ 10 each). The amount provided by the bookrunners is always higher than the amount provided by participants.

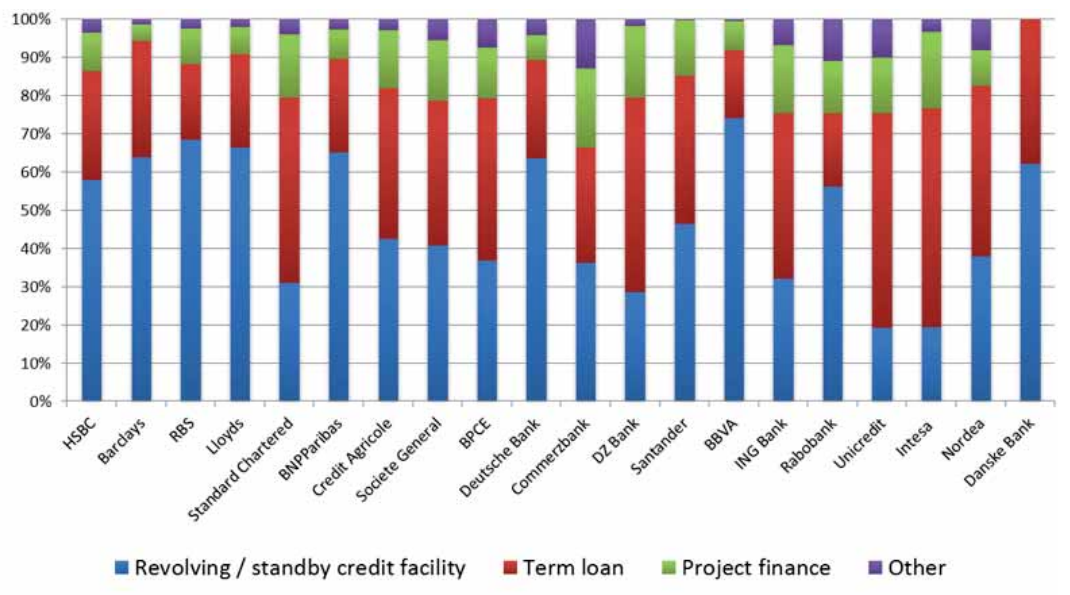
Figure 10 breaks down the facilities provided to high-carbon companies by type of loan based on total value. With more than 50%, revolving credit facilities and standby loans take up the largest share. The assumption that revolving credit facilities are outstanding may exaggerate the actual exposure to high-carbon as it cannot be predicted whether these credits will actually be drawn down or not. However, this approach better reflects the potential maximum exposure, and therefore the actual risk the banks are facing. Another very important instrument is term loans, which are usually used for general corporate purposes and as working capital. The share of project finance is at least 11%, though it may not always have been identified as such. Trade finance accounts for almost 3% of the analysed syndicated loans; letter of credit and guarantee facilities, acquisition finance and other forms of financing all remain below 1%. As trade finance is often not syndicated, the share of trade finance in total loans to high-carbon companies will be higher than the figure shows. This hardly makes a difference for this analysis, however, because trade finance loans are usually provided for a few months only and are therefore unlikely to be affected by the carbon bubble.

Figure 10: Types of financing provided to high-carbon companies



** incl. capital expenditure facility*
*** incl. subordinated debt, mezzanine debt, debentures, performance bonds, loan style bonds, Islamic finance.*
Source: Thomson ONE Banker, "Syndicated loans", Thomson ONE Banker, viewed November 2013

Figure 11: Types of outstanding loans to high-carbon companies as of 31 Dec 2012



Source: Thomson ONE Banker, "Syndicated loans", Thomson ONE Banker, viewed November 2013

Figure 11 shows the distribution of value among different types of outstanding loan facilities for individual banks. While for all banks revolving credit facilities and term loans play the most important role, different distributions and shares of project finance can be observed. This includes, for example, the financing of new oil rigs like the Alpha Star Rig, the development of oil fields like Jubilee Oil Field off the coast of Ghana or the financing of drill-ship construction.

A comparatively large share of project-related finance in the high-carbon loan portfolio was found for Commerzbank with 21%, Intesa San-Paolo with 20%, DZ Bank with 19% and ING Bank with 18%. On the other hand, for some banks only small shares of project-related finance were found, namely for Danske Bank which had no facilities, Barclays with a 4% share, Deutsche Bank with 6% and Lloyds with 7%.

Based on total assets, the highest share of project finance to fossil fuel companies was found for ING and Standard Chartered with 0.3%.

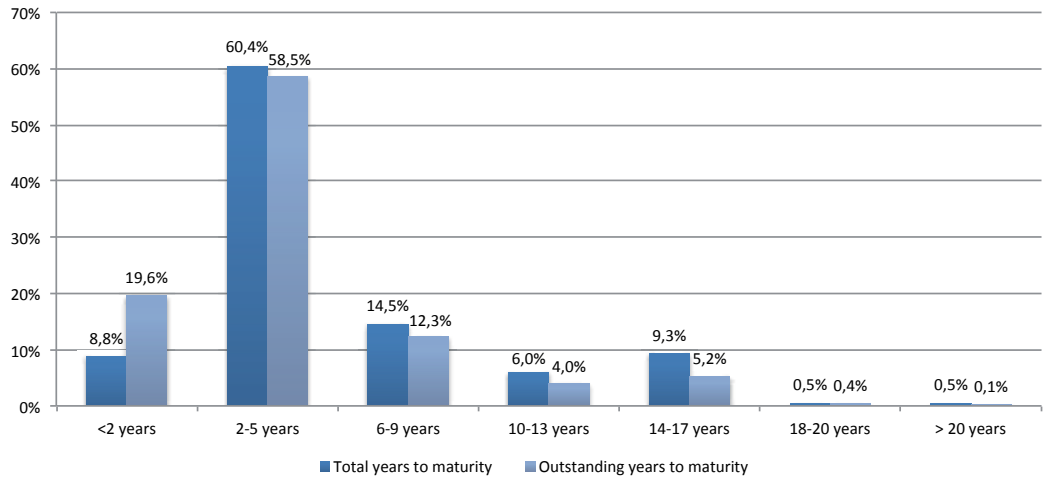
Overall, more than 80% of the total value of the facilities was provided to companies involved in the exploitation of oil and gas, the remainder was obtained by coal mining companies.

The total maturity of the analysed facilities based on their value as well as the outstanding years to maturity as of end of year 2012 are analysed in *Figure 12*.

The original maturity of the analysed loans ranges between less than two years and more than 20 years. The majority of loans (60%) by value have maturities of between two and five years. Short maturities of less than two years apply for 9%. 14% have maturities between six and nine years, 6% between 10-13 years, followed by maturities between 14 and 17 years for 9% of the deals. Long maturities of 17 years and more were found for only 1% of the loans.

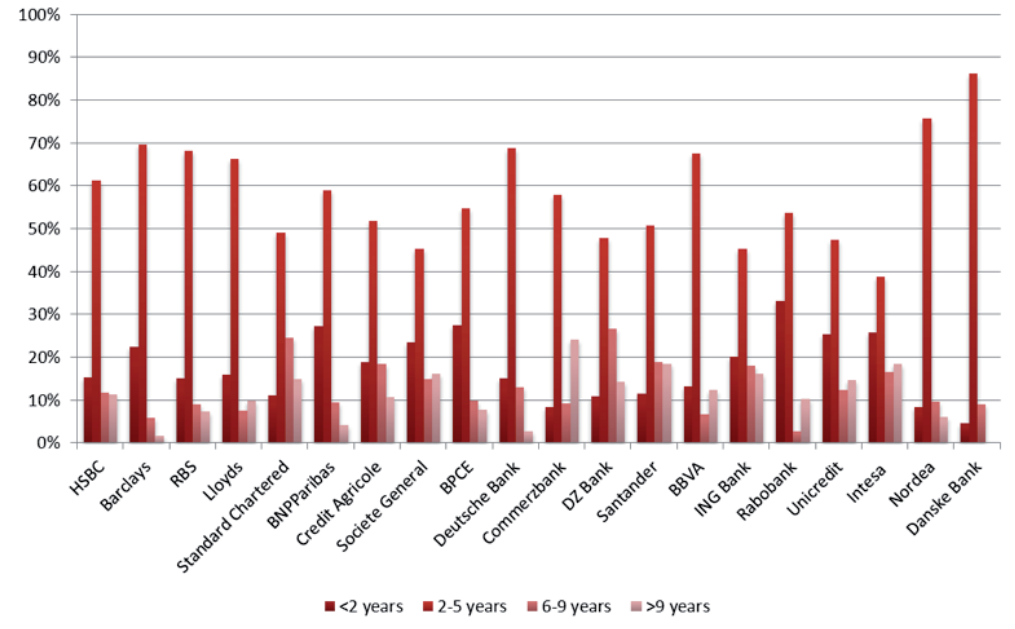
When looking at the outstanding years to maturity at the end of 2012, the picture looks slightly different. The most significant differences can be seen for loans with less than two years to maturity, which take up a 20% share of the total value and those running for 14 to 17 years with a 5% share. Overall, 22% of the analysed loans have at least six years to maturity remaining and about 10% have maturities of ten years or more.

Figure 12: Original and remaining maturities of loans to high-carbon companies as of 31 Dec 2012



Source: Thomson ONE Banker, "Syndicated loans", Thomson ONE Banker, viewed November 2013

Figure 13: Remaining maturity of loans to high-carbon companies as of 31 Dec 2012



Source: Thomson ONE Banker, "Syndicated loans", Thomson ONE Banker, viewed November 2013

Figure 13 breaks down the outstanding value of loans provided by the 20 banks by remaining years to maturity as of the end of 2012. The years to maturity were clustered in four categories: less than two years, two to five years, six to nine years and more than nine years.

It illustrates that some banks have a much higher exposure to long-term loans to high-carbon companies than others. Four banks stand out with a large share of long-running high-carbon loans. German Commerzbank holds 24% of the loans with an outstanding maturity of more than nine years. In total, 33% of the bank's loans have a maturity of six years and longer. German DZ Bank has a share of 41% of loans with an outstanding maturity of at least six years, with 27% maturing within six to nine years and 14% after more than nine years. UK-based Standard Chartered has a comparable share of longer-running loans outstanding. Spanish bank Santander shows a 38% share of loans with maturities of six years and longer.

Among the banks with a small value-share of corporate loans in their portfolio with maturities of more than nine years include Danske Bank from Denmark for which no such loans were found, UK-based Barclays bank with 2% and German Deutsche Bank with 3%.

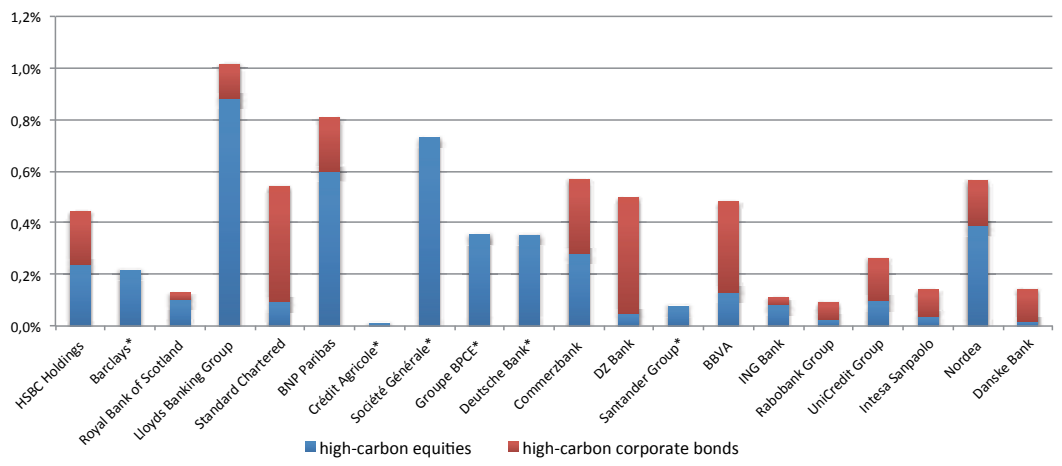
Exposures of high-carbon assets in holdings of equities and bonds

Apart from loans, banks are also exposed to equities and corporate bonds issued by oil, gas and coal mining companies. Banks hold varying amounts of shares and bonds for their own account and are exposed to high-carbon companies in their trading portfolio. These holdings show up in the balance sheet under different headings, including financial assets held for trading, financial assets designated at fair value through profit and loss, financial assets available for sale and investments held to maturity. For this analysis, equity holdings and corporate bond holdings falling under these categories were extracted from the annual reports of the banks. As banks hold varying amounts of government and other publically issued bonds, sometimes accounting for a large share of their portfolio, only those banks that at least provide breakdowns which single out holdings of government and treasury bonds were analysed, which reduces the number of banks that can be considered in the overall analysis. For those banks which do not break down bonds into financial and non-financial corporates, the average distribution between these two categories found in fully-analysed banks was applied in order to estimate the value of holdings in non-financial corporate bonds. The share of bond holdings issued by financial institutions can differ substantially between different banks. For nine banks, the values of non-financial corporate bond holdings are available. On average, these holdings account for 23% of the combined holdings of bonds issued by corporates and financial institutions. For the five banks for which only totals of financial and non-financial bonds are given, this average is applied to estimate the value of non-financial corporate bonds. There was, however, quite a large variation, with shares of non-financial companies ranging between 4% and 47%, which adds some uncertainty to the estimates.

Available data on the composition of trading portfolios are insufficient to track exposures to specific companies. Instead, the exposure to high-carbon companies in leading stock and bond indices is used as a reference value. Based on these values the relative importance of potential losses via trading portfolios is indicated. For equity holdings, the composition of BlackRock's iShares MSCI World UCITS as of December 2012 is used as a reference, for bond holdings the PIMCO Global Advantage Bond Index is used as a benchmark [103]. For equities, the assumed average high-carbon share applied is 9.4%. For bonds, the share of high-carbon companies in the corporate bonds contained in the bond index is applied; this percentage is 15.3%.

Figure 14 shows the high-carbon shares of banks' equity and bond portfolios. High-carbon equity holdings have an estimated value of € 61 billion across all analysed banks. On average, they account for 0.3% of total assets. The value of corporate bond holdings has to be estimated at considerably above € 22 billion as this sum is only based on data for 14 banks. On average, holdings of corporate bonds account for 0.2% of total assets. Adding up the two asset classes, this leads to shares ranging from 0.1% to 1.0% of total assets, with a weighted average of 0.4%. It has to be noted here that corporate bond holdings could only be included for 14 banks.

Figure 14: Share of high-carbon equity and bond holdings in total assets



** = Excluding corporate bonds due to lack of available data*

Source: 2012 annual reports of the analysed banks; BlackRock iShares, "iShares MSCI World UCITS ETF (Inc) (IWRD)", BlackRock iShares, 2013; PIMCO, "Global Advantage Bond Index (GLAD) – Index Constituents", PIMCO, 2013; own calculations.

Combined exposure to high-carbon assets

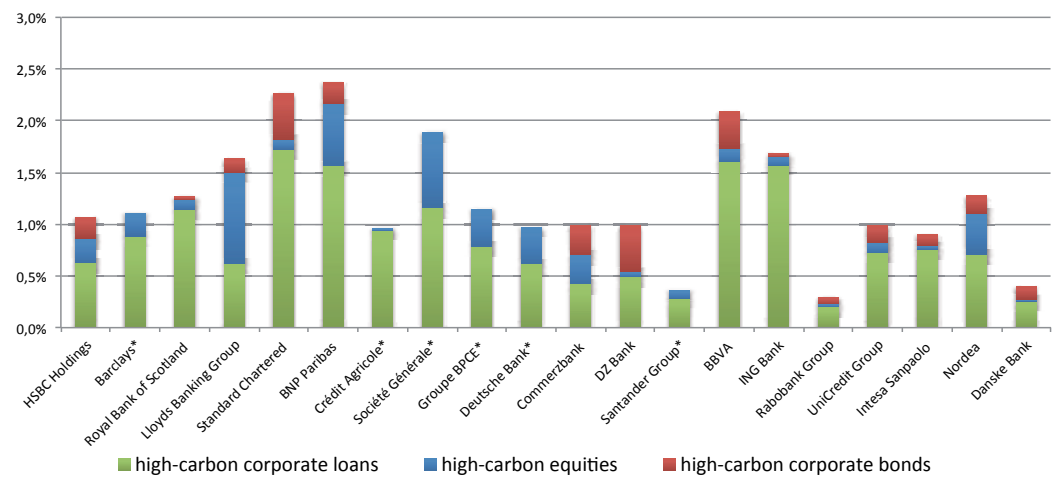
Corporate loans and investments in equities and corporate bonds form the key exposure of European banks to high-carbon companies. When adding up the estimated exposures through these three asset classes, a statement can be made on the estimated total exposure of the analysed banks to high-carbon investments. As in the previous chapter, only 14 banks can be fully analysed due to a lack of detailed data for some of the banks (*Figure 15*).

The combined exposure ranges between a minimum of 0.3% and a maximum of 2.4%. The weighted average is 1.4% and the total value of these assets adds up to € 188 billion. Note again that corporate bonds could not be considered for six of the banks. BNP Paribas stands out with the highest share of high-carbon exposure, standing at an estimated 2.4% of its total assets. This is followed by UK-based Standard Chartered with 2.3% of total assets. Danske Bank from Denmark, Dutch Rabobank and Spanish Santander have the smallest exposures.

Extrapolation to all EU-based banks

By assessing the relative share of banks' high-carbon exposures in relation to their total assets, these findings can be extrapolated across the relevant sectors in the EU to give an indication of the exposure of the sectors as a whole to the carbon bubble. According to the European Central Bank (ECB), EU-based banks had consolidated total assets of € 35,472 billion as of the end of 2012. This figure includes the global assets of EU-based banking groups (e.g. Standard Chartered Bank Ghana), but excludes European subsidiaries and branches of non-EU banking groups (e.g. Citigroup's corporate and investment banking unit in Germany). [104] Note that some of the Eurozone operations of non-EU banking groups are relatively large and will therefore be subject to the ECB's single supervisory mechanism for large Eurozone banks. Potential effects on financial stability in the EU through the exposures of foreign banks are not analysed in this report. The top 20 EU-based banks have total assets of € 22,056 billion, representing 62% of the total assets of all EU-based banks. The 14 banks that are fully analysed in this report have total assets of € 12,960 billion, representing 37%.

Figure 15: Combined exposure to high-carbon assets as share of total assets



** = Excluding corporate bonds due to lack of available data*

Table 4 provides an extrapolation of the findings to all EU-based banks. Average investments of 3.0% in equities and 0.3% in high-carbon equities, result in a total estimated shareholding value of € 1,064 billion and a value for high-carbon shareholdings of € 106 billion. For corporate bond holdings, the analysis results in an estimated total value of € 532 billion, and high-carbon corporate bond investments of an estimated value of € 71 billion, representing 0.2% of total assets.

An average share of 0.9% of loans to high-carbon companies results in an estimated € 319 billion of outstanding high-carbon loans across the EU-based banks. Considering that the total value of corporate loans provided by EU-based banks as of the end of 2012 stands at € 5,300 billion, this represents a 6% share [105]. This is very close to the 5.7% weighted average in total corporate loan portfolios (based on the analysis of the top 20 banks).

Table 4: Extrapolation of findings to EU banking sector

	Calculated average % of total assets based on top-EU banks' analysis	EU-sector extrapolation based on € 35,472 bn total assets of EU-based banks (€ bn)
High-carbon equities	0.3%	98
High-carbon corporate bonds	0.2%	62
High-carbon corporate loans	0.9%	303
Total high-carbon exposures	**1.3%**	**463**

Based on these assumptions, high-carbon assets in the portfolio of European Union banks had an estimated value of € 463 billion at the end of 2012, with corporate loans to fossil fuel companies accounting for almost two thirds of this.

Using an alternative approach, the average share of high-carbon assets distributed over equity and corporate bond holdings and corporate loans were first extrapolated on the national level, based on national bank assets excluding foreign subsidiaries on the domestic market. This extrapolation includes considerable uncertainties as, for bond holdings, only 14 banks could be analysed and for two countries estimations are based on figures for one bank only. Average investments in high-carbon shares between 0.3% and 0.4% on the national level, between 0.1% and 0.4% for bond holdings, and between 0.3% and 1.1% for corporate loans result in estimated high-carbon shareholdings of € 81 billion, high-carbon bond holdings of € 77 billion and high-carbon loan portfolios of € 277 billion across the eight countries analysed. The countries for which banks were included in the analysis account for 91% of all the assets of EU-based banks [106]. Scaling this up to the European level results in a, very similar, estimate of high-carbon assets of € 477 billion.

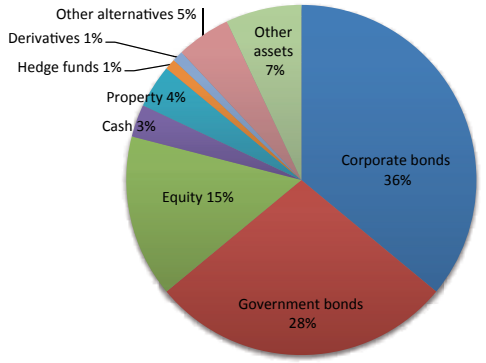
Thus, extrapolating the national findings to the European level, high-carbon assets held by European Union banks had an estimated value of approximately € 460-480 billion at the end of 2012. This is based on more than one third of total EU bank assets for holdings of corporate bonds and almost two thirds for equities and corporate loans. It should thus provide a reasonably reliable indication of the total exposure of banks to high-carbon companies. Small EU banks may have a stronger domestic or non-corporate focus and less exposure to high-carbon firms, but this only marginally affects the estimate because of their smaller balance sheets. Considering that the high-carbon industry definition was kept very narrow and exposure through bilateral loans were not considered in the calculation, the estimate of total exposures of EU-based banks to high-carbon firms is, in fact, conservative.

Exposure of EU insurance companies to carbon bubble risks

Insurance companies could not be included in full detail in this analysis. This is partly due to limited resources and partly due to the limited availability of sufficiently detailed data.

According to estimates by auditing company PriceWaterhouseCoopers and Insurance Europe, the European insurance industry held € 7,700 billion in their investment portfolio in 2011 [107]. *Figure 16* illustrates the average breakdown of asset allocation by European insurers in 2011. Corporate bonds take the largest share with 36%, followed by sovereign bonds with 28% and equity investments with 15% of the total.

Figure 16: European insurers' asset allocation (end 2011)



Source: Economist Intelligence Unit, Insurance Europe, Oliver Wyman analysis, In: Wyman, O., Funding the future – Insurers' role as institutional investors", Insurance Europe, June 2013.

These figures vary considerably between companies and countries depending on local requirements and conditions. At the company level, the types of insurance products sold have an impact [108]. At the national level, insurance companies in continental Europe tend to invest larger shares in government bonds than their counterparts in the UK [109].

Based on this average investment distribution, an estimate for the exposure of the European insurance sector can be made. Applying the high-carbon distribution found in the analysed equity and bond indices of 9.4% and 8.4%, respectively, gives an estimated exposure of € 109 and € 233 billion, respectively, adding up to an estimated € 342 billion of high-carbon investments through the equity and debt holdings of European insurers. This is equal to 4.4% of the total assets of EU insurance companies.

Impact of the carbon bubble on the EU financial system

Potential shocks to financial institutions

The previous chapters analysed the exposures of EU pension funds, banks and insurance companies to firms holding fossil fuel reserves. The total estimated exposures are roughly € 260-330 billon for EU pension funds, € 460-480 billion for banks and € 300-400 billion for insurance companies. These large figures raise serious concerns about the potential consequences should these investments end up as stranded assets.

Should a carbon bubble shock occur, these exposures will generate losses for individual financial institutions. The size of the losses depends on the amount and type of exposures as well as on the magnitude of the shock and the time period over which it occurs. In the case of a sudden crash, financial institutions will immediately bear the full cost of downward adjustments in equity and bond prices and required loan loss provisions. In the case of rapid change that occurs over a period of several months, financial institutions may be able to take certain measures to reduce their losses. For example, some pension funds may be able to rebalance their portfolio during the adjustment, actively reducing their exposure to high-carbon firms during the transition period, resulting in somewhat lower losses.

Furthermore, some types of exposures will generate larger losses than others. Equity investments are one of the most affected types of exposures, because shareholders bear the largest risks and absorb the first losses, before bondholders and other creditors. The value of equity investments in high-carbon firms is also directly based on the expected cash flows from fossil fuel reserves. Equity investments are most important for pension funds, but also substantial for insurers and banks with investment banking businesses. High-carbon equities account for 12% of total assets for the pension fund with the highest exposures, and an estimated average of 3% of total assets across the European pension fund sector.

Longer-term bond exposure would then be hit. These are an especially important investment category for insurers. In the benchmark bond index, the average remaining maturity of bonds issued by high-carbon companies is approximately 11 years. This means that the risk profile and valuation of these bonds depends on the capacity of fossil fuel companies to meet their financial obligations over a long time horizon, beyond the point where actual production will need to be scaled down due to stranded assets. Thus, depending on the balance between lower cash flow generation and lower investment needs, the capacity of fossil fuels companies to fully repay their long-term debt may be reduced, resulting in falling bond prices.

Corporate loans are a key source of vulnerability for commercial banks. The individual exposure of banks varies considerably, ranging from close to zero to almost 2% of total assets, with an average exposure of approximately 1%. The impact of a carbon bubble shock on corporate loans depends on the type of loans provided to fossil fuel companies. The main types were found to be revolving credit facilities and term loans, followed by project finance. Revolving credit facilities may pose a comparatively small risk in normal times. In a carbon bubble shock scenario, however, fossil fuel firms may draw the full amounts of these facilities for as long as possible and may prioritise paying off other maturing loans first. The risk attached to term loans depends on the outstanding years to maturity. With an estimated 10% of the outstanding loans provided by European banks to fossil fuel companies having at least 10 years to maturity, cash flows at the time may not be sufficient to repay these loans. Banks will continue to receive interest payments – as the cash flows will not be affected directly – but they will need to make provisions for expected losses. Project-related financing could be especially critical as there is a high likelihood that banks will face losses if individual projects are abandoned, for example due to higher carbon taxes. The risks depend on the nature of the projects, however, as low-cost projects may continue to be commercially viable. The highest share of fossil fuel project financing found reached 0.3% of total assets.

It is important not to look at losses at the sector level only, but to consider large individual institutions as well. The reason is that the commercial banking and pension fund sectors as a whole may be able to handle considerable losses, but if the losses are concentrated at specific institutions, this may cause immediate distress for those institutions, resulting in a larger overall impact. The reason is that many institutions may be able to absorb small losses as part of their normal operations, but a single institution confronted with a large concentrated loss may experience acute distress and pass on shocks to others. The mechanisms through which shocks are passed on are discussed below.

Potential propagation channels and feedback loops

If an individual financial institution faces a relatively large shock, this may trigger further shocks elsewhere in the financial system and the broader economy. The following overview briefly outlines the main propagation channels for individual financial institutions.

What could occur if an individual pension fund suffers losses:

- If the loss is large, or the funding ratio of the pension fund was already low, the employer may be required to make an additional one-off contribution to the pension fund to cover the funding shortfall. Whether such an obligation exists depends on the pension contract; for most pension funds, the employer may be under pressure to make a higher contribution but there is no automatic obligation. The cost of an extra contribution may cause an unexpected loss for the employer.
- If the loss is large or the funding ratio of the pension fund was already low, the pension premiums for employees may be increased or the pension entitlements for employees and pensioners reduced. This could have an effect on consumer confidence and demand and hence the economic cycle. Increasing premiums has a direct effect on the net income of employees. Decreasing entitlements has a smaller direct effect on the income of pensioners only, but may reduce confidence among a broader group of consumers.
- If the loss is large, the pension fund may lower its risk profile to reduce the risk of further losses. In general, pension funds do this by increasing the proportion of their assets in relatively safe assets, especially low-risk sovereign bonds, at the expense of high-risk asset classes such as listed equities, private equity and real estate. To some extent, such a shift happens automatically if the share values of fossil fuel companies fall and a pension fund does not rebalance its asset mix. However, a pension fund may also actively reduce its equity investments and investments in other high-risk assets categories. Such behaviour could have a broader effect on specific financial markets.

If an individual bank suffers losses:

- The market value of the bank will fall, generating losses for shareholders of the bank.
- If the loss is large, the risk premium for the bank's market funding will increase and the credit rating of the bank could be adjusted downwards. This reduces the value of the bonds issued by the bank, generating losses for bondholders.
- If the loss is large, the bank may try to restore its capital ratio by reducing the size of its balance sheet. In other words, the bank could restrict new lending, especially to high-risk segments such as small and medium enterprises, to reduce its overall risk exposure as its capacity to bear risks has been decreased. This could lead to higher borrowing costs or even unavailability of credit for small businesses that are dependent on the bank and cannot easily switch to another source of credit.
- If a bank with investment banking operations suffers large losses on financial investments for its own account, traders may try to quickly sell the high-carbon assets to limit their losses. In contrast to pension funds, it is likely that the behavioural response would be quick and only affect the market for high-carbon assets, but it could potentially have a broader effect on stock markets.
- If the loss is very large and the bank's capital buffers were already low, this may trigger the need for recapitalisation. Depending on the bank's funding structure and the market situation, private recapitalisation could take place through a claim emission, imposing further losses on existing shareholders, or the conversion of subordinated debt, imposing losses on holders of subordinated debt securities, including pension funds and insurance companies. When the EU Bank Recovery and Resolution Directive comes into force, the bail-in of senior bondholders will become a possibility. (The compromise text of the directive was agreed upon in December 2013 and is to be formally adopted by the EU Parliament and the Council).
- If further recapitalisation is needed and a private solution is not possible, the government of the bank's home country may need to provide a capital injection. This may be the case if uninsured corporate and institutional depositors start to withdraw their money and the bank faces difficulties in obtaining market funding, depleting the bank's liquidity buffers and creating a real danger that the bank cannot survive on its own. In the current situation, the government may then need to step in to restore confidence. This will increase the government's debt burden and exposes the government to large financial risks. (The EU's single resolution fund that was agreed on in December 2013 will initially consist of national compartments. In the coming years, the capacity of the fund therefore mainly depends on contribu-

tions from the national banking sector, which will be insufficient to recapitalise large banks).

If an individual insurance company suffers losses:

- The market value of the company will fall, generating losses for shareholders of the insurer.
- If the loss is large, or the solvency ratio of the insurance company was already low, this may trigger a need for recapitalisation. Similarly to a bank, private recapitalisation could impose additional losses on existing shareholders or holders of subordinated debt securities. A public capital injection by the government would only occur in extreme situations because, unlike a bank, an insurance company will not usually run into immediate liquidity problems due to the long-term nature of its obligations.
- Similar to a pension fund, the insurance company may lower its risk profile to reduce the risk of further losses. This could involve actively reduce its equity investments and investments in other high-risk assets categories; such behaviour could have a broader effect on specific financial markets.
- Insurance premiums might have to go up to compensate for lower returns on the investments of insurance firms.

If substantial shocks occur to various financial institutions at the same time or to a whole sector, which would happen in case of a carbon bubble shock, harmful feedback loops may occur. First, if many banks and institutional investors start actively selling high-carbon assets, this could put more pressure on the market prices of these assets, triggering further sales. This could result in a negative price spiral, similar to what happened in the market for mortgage-backed securities. Thus, markets could overreact. If stranded assets were to reduce the market value of oil and gas companies by 40%, a negative price spiral could then temporarily increase the fall in share prices to, for instance, 60%. Note that large market effects will occur only if a broad range of market participants, not just investors that divest from fossil fuels for ethical reasons, change their risk perception of high-carbon assets [110].

Second, if many pension funds and insurers start reducing their risk profile this could increase the price of low-risk sovereign bonds. This, in turn, would drive down the risk-free returns that institutional investors can obtain on safe assets and therefore lower the risk-free interest rate that institutional investors use to determine the value of their future obligations. Because of incomplete matching of assets and liabilities, this would exacerbate pension funds' funding shortfalls and further reduce the solvency of insurers. The result could be a flight-to-quality spiral, similar to what happened over the past years in the Eurozone and in other EU countries like Sweden. The result could also be lower pensions.

Third, if many commercial banks suffer large losses and restrict lending to businesses to rebalance their exposures and risk-bearing capacity, investment would become constrained, harming the overall economy. This could lead to further losses on corporate loans, create a negative deleveraging spiral, or reinforcing the deleveraging dynamics that already exist in some EU countries.

Fourth, if many pension funds need to substantially reduce pension payments, this would reduce the income of pensioners and probably lead to lower consumption. Similarly, if pension funds need to substantially raise pension premiums, this would raise employment cost or reduce net wages (depending on how the rise in premiums is distributed between employers and employees). The result would be lower economic growth as well as various potential feedback effects, especially for pension funds that have a high exposure to domestic sectors, such as home-country equities and real estate. Lower growth also worsens the financial position of the government, which negatively affects the value of government bonds held by all financial institutions.

Fifth, if it turns out that several large financial institutions have underestimated carbon bubble risks, this may reduce consumer confidence and increase the risk perception of market participants. Due to the resultant fall in consumer confidence, the effect of reducing pension entitlements could be much larger than the direct consequences for pensioners of specific funds. There could also be a strong negative effect on consumer confidence if the government needs to support banks or insurance companies. In fact, even the signal that large financial institutions could be more vulnerable than they appear and have not managed large risks appropriately may already reduce consumer confidence. This, in turn, could reduce consumption and short-term economic growth. In addition to the feedback effects for pension funds mentioned above, lower growth could generate a negative spiral for banks

through increased domestic credit losses. Creditors and counterparties of financial institutions may also react to negative signals about the vulnerability and risk management of these institutions. This could lead to increased funding costs for banks and insurance companies, which would be largely passed on to customers and could therefore also generate feedback effects through lower growth.

The vulnerability of individual institutions, the likelihood of knock-on effects through the passing on of shocks, and feedback effects at the macro level all depend on the broader economic scenario in which a carbon bubble shock occurs. With a weak economic outlook and capital buffers that are low to start with, losses due to high-carbon exposures will be more difficult to absorb. The propagation of shocks, and thus also the harmful feedback effects triggered by such shocks, depend on whether an institution is able to recover on its own. For all financial institutions, this in turn depends on broader economic developments and expectations about future economic developments. Moreover, the ability of banks and insurance companies to recover also depends on how their creditworthiness is perceived by market participants. Even if a carbon bubble shock by itself only generated a modest shock, in the case of continued economic fragility in the Eurozone, that shock would come on top of other causes of financial instability and could be trigger harmful feedback loops. Moreover, this report estimated only the potential losses on exposures to fossil fuel firms and commodities. The impact of a carbon bubble shock will be larger, because it also affects other sectors and investments.

"Low-carbon Breakthrough"

A carbon bubble shock can be defined as a quick and large fall in the value of fossil fuels. To assess the potential impact of a carbon bubble shock on the EU financial system, the magnitude of losses for individual financial institutions will be roughly estimated on the basis of a particular shock scenario. The main scenario assumes a quick and definite transition towards a low-carbon EU economy. This breakthrough could result from decisive global politics determined to limit climate change. Such political developments may seem unlikely in the wake of various failed efforts to reduce greenhouse gas emissions at both the global and EU level; however, there are some signs that quick changes in policies are nonetheless possible. Take the promotion of biofuels, for example, which have replaced 5% of fossil fuels used in transportation in the EU. Although their ameliorative impact on climate change is doubtful (the cultivation and processing of first-generation biofuels also causes high emissions), the example shows that deliberate policies can quickly change energy markets. Policy changes are not necessarily driven by concerns about climate change alone, but can also be a response to concerns about air pollution or dependence on energy imports. China, for example, which is currently the main source of increasing greenhouse gas emissions, is taking strong measures to increase the use of gas as fuel for vehicles and industrial production because it is cleaner than oil and coal. Decisive politics probably require a trigger, such as a catastrophic drought or flooding that can in part be attributed to climate change due to the increased probability of their occurrence under changing climate conditions. The breakthrough could also be driven by technological developments, such as a breakthrough in renewable energy generation that would make this a very competitive alternative.

The low-carbon breakthrough scenario assumes the following shocks to the exposures of financial institutions:

- The value of equity investments in oil, gas and coal businesses falls by 60%. This is in line with HSBC's analysis of oil and gas companies, discussed in the background section, which assumes a low oil price of USD 50 per barrel. For diversified mining companies, the fall in value only applies to coal mining operations.
- The value of fossil fuel commodity investments falls by 50%. Pension fund investments in commodities typically track commodity indices and these move in line with the underlying commodity prices.
- The value of the long-term bonds of oil, gas and coal businesses falls by 30%. This assumption takes into account the long remaining maturities of average bond holdings, which implies a substantial increase in credit risk. For some firms, cash flows from production of fossil fuels compatible with a strict carbon budget and low oil prices will be insufficient to repay long-term bonds. For other firms, reducing dividend payouts and immediately ceasing all investments in projects that would be unsustainable under a low-carbon scenario may be sufficient to ensure full repayment of outstanding bonds. However, even for these firms credit risks will increase, for

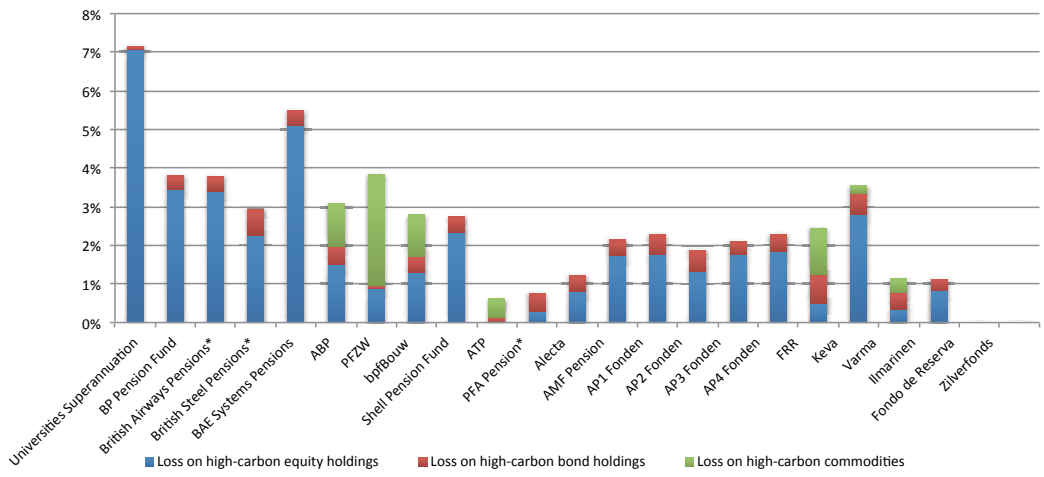
example due to uncertainty over the successful completion of the transition and the downsizing of the firm.

- Losses on the project financing of individual oil, gas and coal projects of 30%. As discussed above, project financing can be a high-risk type of exposure because banks will face large losses if individual projects are abandoned.
- Losses on term financing provided to oil, gas and coal projects of 30%. These credit losses are similar to the losses on long-term bonds.
- Losses on revolving and stand-by credit facilities to oil, gas and coal projects of 20%. Due to the shorter remaining maturities of these loans, typically up to five years, smaller losses would be expected.
- Losses on other loans to oil, gas and coal projects of 5%. The nature of these loans is unknown and they may be short-term or secured, limiting the potential losses.

Note that these assumptions specify average losses only, which are applied to all financial institutions. In reality, the precise nature of high-carbon exposures differs among institutions. For example, one bank may have more unsustainable unconventional oil projects or loans to coal mining companies in its oil, gas and mining credit portfolio than another bank. The estimates in this analysis do not account for such differences between institutions within a single type of exposure.

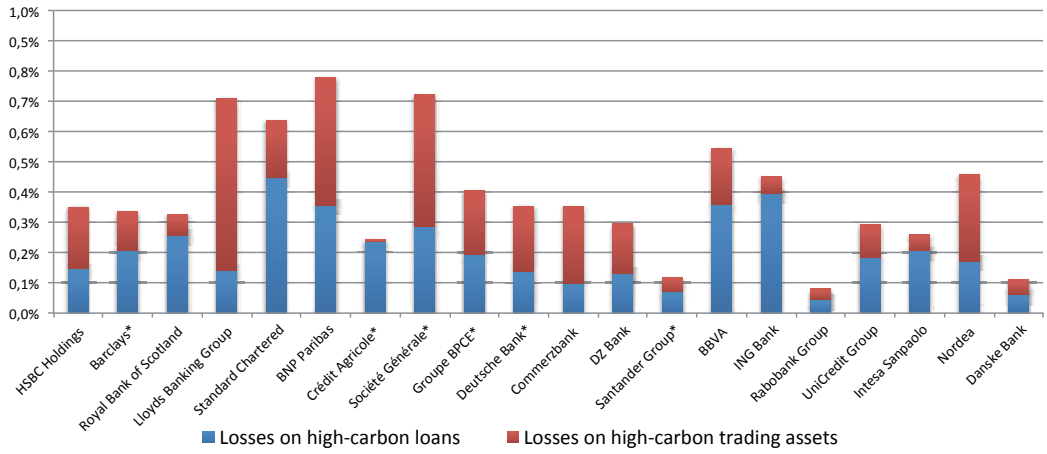
Figure 17 provides an overview of the estimated losses of pension funds, expressed as a share of total assets. The table shows that the weighted average loss for these 23 pension funds is approximately 2.5%. For the EU pension sector as a whole, estimated losses would be in the range of 2.5-3.4%, because the UK's large pension sector is more exposed to fossil fuel assets. This implies a loss of € 130-180 billion on € 5,100 of total assets. The estimated loss is relatively limited and comparable to the impact of regular developments in overall equity markets or interest rates over a one-month period. The reason for this relatively small effect is that many pension funds have either a small proportion of equity to total assets or a small proportion of fossil fuel firms in their equity portfolio. Thus, for these funds, a large shock to the value of oil, gas and coal mining companies has only a limited effect on the total value of their investments. While a carbon bubble shock would cause significant losses to the EU pension sector as a whole, it is unlikely that a shock of this size would trigger a flight to quality or other negative feedback loops.

Figure 17: Estimated losses of pension funds (% of total assets)



** = Excluding commodities due to lack of available data*

Figure 18: Estimated losses of banks (% of total assets)



** = Excluding losses on corporate bonds due to lack of available data*

UK and Dutch pension funds are an exception, though. UK funds allocate a large part of their investments to listed equities and have a high proportion of fossil fuel firms in their equity portfolio – probably because of the large weight of these companies in the total market capitalisation listed on the London Stock Exchange. The UK Universities Superannuation Scheme stands out as the most vulnerable fund, with estimated losses of approximately 7% in the case of a low-carbon breakthrough. Such a shock could reduce the pension entitlements of its participants by a similar amount and should therefore be avoided. Large Dutch pension funds allocate a substantial part of their investments to high-carbon commodities. PFZW, the Dutch fund with the largest commodity exposure, could suffer an estimated loss of almost 4% of total assets.

Figure 18 provides an overview of the estimated losses of banks, also expressed as a share of total assets. The table shows that the average loss is approximately 0.4% of total assets (€ 140 billion of losses on € 35 trillion of total assets). Note that this figure should not be compared to pension funds. For banks, the impact of a concentrated loss depends on the capacity of the bank to offset the loss with other income streams and then to absorb the remaining shock through its capital buffer. Many commercial banks report an annual income before tax equal to 0.3-0.6% of total assets and have capital buffers of 3-5% of total assets. Thus, a 0.4% concentrated loss could wipe out the annual income of the entire EU banking sector. The risks to the EU banking sector as a whole are therefore significant, but a one-off 0.4% loss may not trigger negative feedback loops in the EU or the Eurozone as a whole.

It is remarkable that, on average, the estimated losses in investment banking are as large as those in corporate lending. This can be explained by the size of the shocks. The largest part of the high-carbon investment assets consists of equity, which would suffer a large shock. The corporate loan exposures are larger, but more than half of these exposures consists of credit facilities that will cause only minor losses due to their short-term nature.

Like pension funds, the impact differs considerably between banks. The most vulnerable banks could face losses of 0.8% of total assets. This is a very substantial shock. Of these banks, Lloyds would be mostly affected via their trading books, whereas BNP Paribas and Société Générale would suffer comparable losses on trading and corporate lending assets. By contrast, Standard Chartered and ING Bank, which are also vulnerable, would be mainly affected by losses in their corporate loan book.

It is worrying that the most vulnerable financial institutions include two of Europe's largest banks both of which are based in France: BNP Paribas and Société Générale. Whereas risks to financial stability for the EU as a whole seem limited, the risk for France is much larger. French institutional investors may have a relatively high exposure to domestic banks and could thus be hit harder in the case of a bail-in of subordinated or senior bondholders. Whereas the EU Bank Recovery and Resolution Directive stipulates that shareholders and private creditors should bear losses equalling at least 8% of total assets before government support can be provided, the Directive still needs to be formally approved and transposed into national legislation. Until then, it also remains possible that the government would provide capital support without a bail-in. Public support to either of these banks would put a heavy burden on the French government. Moreover, if both banks were to face constraints regarding new lending to companies, this may have a significant effect on the French economy, even if they first reduced lending outside their home country.

For EU insurance companies, losses can only be estimated at the sector level because individual company data are not available. Applying the same loss assumptions, insurance companies would incur losses of approximately 0.9% of total assets due to high-carbon bond holdings and another 0.9% due to high-carbon equity holdings. The combined loss equals 1.8% of total assets (losses of € 130 billion on € 7,700 billion of total assets). It is likely that loss rates will differ between individual insurance companies, similar to pension funds. Thus, losses may range from less than 1% of total assets for insurance companies with relatively small equity and large government bond allocations, to 3% for insurance companies with relatively large equity and corporate bond portfolios as well as large proportions of fossil fuel firms within these portfolios. In the current low-interest environment, which already puts pressure on the solvency of life insurers that have sold life insurance policies with guaranteed minimum returns, such losses could be difficult to absorb.

The estimates in this section are conservative, because an overall assessment of carbon intensity requires a much broader analysis, including assessing the exposure of the financial sector to companies in, for instance, the car industry, the steel industry and the transport sector, as well to asset classes such as real estate. Moreover, within sectors such as the electricity industry, one might need to assess exposure to high-carbon producers versus exposure to low-carbon producers to get a full picture of the vulnerability of financial institutions. Effects on the revenues of EU governments with oil, gas or coal reserves, such as the UK (oil) and Germany (lignite coal), as well as on credit risk of non-EU governments with large fossil fuel reserves, such as Russia and Australia, would be relevant as well. Finally, the potential overreaction of markets, resulting in larger short-term losses, has not been taken into account.

The conclusion for this scenario is that risks to financial stability at the EU level as a whole are limited, but risks to some individual financial institutions are large. This means that greater attention must be given to the management and mitigation of carbon bubble risks in order to prevent large concentrated losses at systemically important financial institutions in the EU. At the national level, the UK is vulnerable because of the large exposure of its pension sector to high-carbon equities. Furthermore, France is vulnerable due to the high exposure of BNP Paribas and Société Générale, mainly in their investment banking businesses. Systemic risk due to negative feedback effects appears higher in these two countries than in the EU as a whole. Elevated risks may also be present for other large individual institutions or the national financial sectors of other EU countries that were not included in the analysis.

"Uncertain Transition"

The main scenario above assumed a quick and definite transition towards a low-carbon EU economy, resulting from decisive political action or a major technological breakthrough. The transition may not be quick and certain, though. This section, therefore, will discuss the effects of a second scenario featuring a slower and uncertain transition. These effects are more difficult to quantify and will therefore be mainly discussed qualitatively. However, by comparing these effects with the low-carbon breakthrough scenario, it becomes clear that the risks to financial stability are potentially larger.

In this scenario, catastrophic climate change will eventually still be avoided, which means that CO_2 emissions cannot exceed the carbon budget for global warming of two degrees. However, it is assumed that EU policies remain insufficient to restrict greenhouse gas emissions, focused

on short-term interventions and partial solutions, for a prolonged period (five years or more). During this period, an overall policy framework is lacking. Measures are mainly adopted at the national level and are sometimes inconsistent; various measures are reversed or replaced after a few years. Thus, climate action is always taking two steps forward, one step back. The dangers of climate change are increasingly being recognised over the years and policies become gradually more ambitious but, due to the short-term nature of politics, the transition path remains highly uncertain initially. The uncertain transition may also be driven by slow and uncertain technological advances rather than short-term policies. Instead of a major technological breakthrough, competing technologies may emerge, or there may be major technological setbacks after an apparent breakthrough. Thus, whether driven by politics or technology, the timeframe and path of the energy transition remain highly uncertain for a longer period. Ultimately, the adjustments required to limit global warming will need to be stronger, however, because they will take effect after years of uncertainty during which greenhouse gas emissions will have risen much higher than in the low-carbon breakthrough scenario.

The effects on the financial system differ from the main scenario in three ways. First, as the transition occurs slowly, financial institutions will not be hit by a sudden shock but incur investment and credit losses over a period of several years. This means that financial institutions will be better equipped to absorb losses on high-carbon exposures. Banks and insurance companies will be able to offset the losses against profits generated over a longer period, limiting the impact on existing capital buffers. Moreover, all financial institutions will have time to restore or strengthen their capital buffers after the first losses on high-carbon assets, if necessary. Thus, compared to a low-carbon breakthrough, it is less likely that large financial institutions will experience immediate distress due to sudden losses and this reduces the risk that they will pass on shocks through the financial system.

Second, as initial progress towards a low-carbon economy is slow and lacks credibility, fossil fuel firms will continue to develop new reserves. Current capital expenditures stand at approximately € 500 billion per year, mainly for oil and gas projects. To put these annual capital expenditures into context, the market capitalisation of large fossil fuel firms is approximately € 3,000 billion and annual dividend payments are roughly € 100 billion [111, 112]. Annual capital investments are therefore large compared to the market value of the companies and several times as large as annual dividend payments.

The fossil fuel assets owned by listed companies mentioned in the background chapter, of which only 20-40% of can be sold if they have a proportional share in the global carbon budget, reflects current proven reserves (so-called P1 oil and gas reserves, and coal reserves). Their potential reserves, including fossil fuel assets that are still being developed (so-called P2 oil and gas reserves, and coal resources), are twice as large. The capital investments of fossil fuel firms are mainly aimed at increasing the amount of proven, marketable reserves. Thus, until the implications of the carbon bubble are fully realised, fossil fuel firms will initially continue to make large investments in developing reserves that will only increase the total amount of stranded assets [113]. They finance new investments partly with retained profits (equity capital) and partly with debt (bonds and loans). If fossil fuel firms were to stop investing in the development of new reserves, which would happen in the low-carbon breakthrough scenario, they would not need to obtain new loans and issue new bonds to finance those investments. They would also have a larger cash flow available to repay existing loans and bonds (or to increase dividend payments or buy back shares). This would limit future losses for shareholders and creditors resulting from the carbon bubble.

By contrast, in an uncertain transition scenario, the ongoing capital expenditures would eventually generate larger losses on equity as well as on bonds and loans. For the fossil fuel sector as a whole, capital expenditures related to the development of new reserves would be fully lost if global warming were to be eventually contained, as the total carbon budget is fixed. Even if only € 300 billion out of the annual investments were related to the development of new reserves, that would be equivalent to 10% of the current stock market value of oil, gas and coal mining businesses. Thus, the additional losses will be significant compared to the existing exposures of financial institutions.

Third, due to uncertainty about future developments, it will be difficult for financial institutions to assess the climate-related risks of their loan

and investment portfolios. It will not be clear if, how and at what pace a transition to a low-carbon economy will take place. Institutional investors may therefore take little action to mitigate losses on high-carbon assets. They will have sufficient time to divest from these assets before they finally lose a large part of their value but, initially, there will be no clear future vision that would justify such divestments from a purely financial perspective. However, the unpredictable adjustment path of two steps forward, one step back, will gradually increase volatility in the value of high-carbon assets. As a consequence, financial institutions will find high-carbon assets more risky. The same applies to investment in renewable energy and energy savings, however. Thus, it is likely that after a few years of increasing volatility and uncertainty, financial institutions will start to restrict the financing of both high-carbon and low-carbon businesses.

If uncertainty about the value of high-carbon (and low-carbon) assets becomes very high, a particularly grim outcome is possible, with higher risks for financial stability. Financial institutions may no longer trust how other financial institutions value their exposures to fossil fuel firms and some banks and insurance companies could become stigmatised. This is similar to what happened regarding exposures to the mortgage-backed securities and bonds of certain Euro countries during the debt crisis. The stigmatised institutions could then run into funding and liquidity problems, not because of actual losses but because other financial institutions suspect they may be hiding losses. Some financial markets could stop functioning altogether, such as the market for the corporate bonds of high-carbon fossil fuel and low-carbon sustainable energy companies, similar again to what happened in the mortgage-backed security and sovereign bond markets. The lack of reliable market prices would further increase uncertainty over valuations and fears over hidden losses. Stock markets are very unlikely to become illiquid, as these continued to function even during worst of the debt crisis, but large losses on equity exposures would add to the distress of financial institutions and provoke a general loss of confidence. This could trigger various types of shocks, including a credit squeeze due to banks' funding constraints, a flight to low-risk investments with overreacting markets, government support for troubled banks and insurance companies, or restructurings involving the bail-in of other financial institutions. A credit squeeze or flight to low-risk investments is likely to produce negative feedback loops, as described in the previous sections.

On balance, the uncertainty in this scenario worsens the impact on the EU financial system compared to a quick and definite transition. Although financial institutions have more time to absorb losses on high-carbon investments, they are unlikely to take timely action to reduce their exposures. In the end, the total losses for banks, pension funds and insurance companies will be much larger because of ongoing capital expenditures by fossil fuel firms that increase the amount of stranded assets. Furthermore, if uncertainty becomes very high, this could lead to panic in financial markets, triggering large shocks and negative feedback loops.

"Carbon Renaissance"

The previous two scenarios have in common that the carbon budget is largely respected and greenhouse gas emissions are reduced sufficiently to prevent catastrophic climate change. This third scenario briefly outlines what could happen if no transition to a low-carbon economy occurs, but instead a roll back of climate measures takes place.

In this scenario, quickly increasing demand for cheap energy from emerging economies leads to a carbon renaissance and resource-rich countries compete to develop unconventional reserves, such as Arctic oil and shale gas. Existing measures to reduce greenhouse gas emissions are reversed and the Emissions Trading System effectively ceases to function. Financial institutions will not suffer losses due to stranded assets and oil, gas and coal mining companies may even generate larger than expected returns due to rising fossil fuel prices. However, climate change will have profound impacts on the global economy that will cause large losses to the financial sector.

A relatively predictable effect of global warming is the rise in sea levels, which will increase flooding in coastal areas and river deltas, potentially affecting various large cities in the US and China, such as New York, Miami, New Orleans and Guangzhou. This may cause large losses for insurers covering damages in flooded areas, but also for financial institutions with exposures to affected property, infrastructure and businesses. One study estimates that global flood

losses could increase from USD 6 billion per year in 2005 to USD 52 billion per year in 2050 [114]. More generally, floods in densely populated areas will negatively affect economic output.

Global warming will also increase droughts and water shortages in some regions, reducing agricultural productivity, while increasing crop yields in other regions. In addition, global warming in excess of two degrees Celsius is projected to cause substantial region-specific changes in rainfall and temperature, as well as increasing weather variability and extreme weather events. These changes would have further impacts on agricultural output, both positive and negative, and extreme storms and rainfall could cause substantial damage to economies at large [115, 116]. Finally, coping with climate change will involve large adaptation costs for businesses as well as governments and households.

The Stern review, a hallmark report on the effects of climate change, estimated in 2006 that the overall costs of unmitigated climate change could reach 5% of GDP per year [117]. DARA, a climate change monitoring group, estimated in 2012 that climate change already causes losses in the order of 1% of GDP [118].

It can be concluded that the financial losses caused by climate change will likely be severe and far outweigh the gains. It is very difficult to estimate the size and distribution of these losses. Nonetheless, existing studies indicate that unmitigated climate change, which would on balance have a negative effect on the economy at large, poses larger risks to the EU financial system than stranded assets, which would negatively affect high-carbon businesses only.

Conclusions

The carbon bubble matters for financial institutions

The equity, bond and credit exposures of EU financial institutions to firms holding fossil fuel reserves are substantial. The total estimated exposures are roughly € 260-330 billon for EU pension funds, € 460-480 billion for banks and € 300-400 billion for insurance companies. These large figures raise serious concerns about the potential consequences of these investments if a large part of the oil, gas and coal reserves ends up as stranded assets. Expressed as an average proportion of total assets, the estimated exposures are approximately 5% of total assets for pension funds, 4% for insurance companies and 1.4% for banks. The "Low-carbon Breakthrough" scenario that assumes a quick and definite transition to a low-carbon economy would cause average losses on the order of 3% of total assets for pension funds, 2% for insurance companies and 0.4% for large banks. The loss ratio for banks is smaller, because a substantial part of bank exposures to fossil fuel firms consists of credit facilities with relatively short maturities, which will be less affected by a carbon bubble shock. The estimated losses result from exposures to oil, gas and coal mining companies and commodities investments only and do not cover shocks to other sectors, which could also be large. The shocks to other sectors depend on the driving forces of the transition, which could be climate or environmental policies as well as technological developments.

Effective climate policies help to minimise losses

A second "Uncertain Transition" scenario assumes that emissions will eventually remain within the carbon budget, but with a transition path that is initially slow and highly uncertain. This increases the losses for financial institutions, because fossil fuel firms will continue to make large investments in developing new reserves, increasing the amount of stranded assets. Annual capital expenditures are approximately € 500 billion per year which is high compared to, for example, the total market capitalisation of large oil and gas firms of roughly € 3,000 billion. In addition, high uncertainty over future developments could itself become a source of financial instability due to uncertainty about the valuation of high-carbon businesses and fears of hidden losses at financial institutions.

Doing nothing causes the largest risks

A third "Carbon Renaissance" scenario is characterised by ineffective climate policies and quickly increasing demand for fossil fuels. This will eventually lead to catastrophic climate change and increased sea levels, floods, droughts, and extreme storms and rainfall. Existing studies indicate that this scenario causes the largest losses for financial institutions as it seriously harms the global economy and generates large claims for insurance companies.

The carbon bubble alone is unlikely to be a source of systemic risk

On its own, the shock to financial institutions resulting from a quick adoption of climate and energy policies or a breakthrough in low-carbon technology is unlikely to be a source of systemic risk. This is because carbon bubble risks, while significant, are not so large that they pose a threat to the pension, banking and insurance sectors as a whole. Therefore, a carbon bubble shock alone is unlikely to trigger harmful feedback loops within the financial system or between the financial system and the broader economy. Thus, risks to financial stability are not an obstacle to the adoption of effective climate policies. Targeted measures could further reduce the potential negative impacts of a quick transition to a low-carbon economy on the EU financial sector (see *Recommendations* section).

Carbon bubble risks are more dangerous in an environment that is already fragile

In a fragile economic environment, many financial institutions are less able to absorb shocks. This increases the likelihood of knock-on effects through the propagation of shocks and feedback effects at the macro level. Although by itself the carbon bubble is unlikely to be a source of systemic risk, in the case of continued economic fragility in the Eurozone, a carbon bubble shock would come on top of other causes of financial instability and could be the trigger for harmful feedback loops. In such an environment a further reduction of consumer confidence and demand, for instance as a result of further lowering of pensions, would be dangerous, as would be a further squeeze of credit to small and medium enterprises by banks that have been hit by the deflation of the carbon bubble. Furthermore, this

report assesses only the potential losses on exposures to fossil fuel firms and commodities. The total impact of a carbon bubble shock would be larger through the impact on other sectors and investments.

Risks are larger for some individual institutions and national sectors

For some individual institutions or EU countries, the carbon bubble risks are much larger. To prevent large concentrated losses at financial institutions that are systemically important, either individually or as a group, the management and mitigation of carbon bubble risks requires more attention. Most of the pension funds with the largest exposure to the carbon bubble are from the UK, including the Universities Superannuation Scheme, BAE Systems Pension Scheme and British Airways Pensions. Dutch PFZW and Finnish Keva also seem relatively exposed. Under a low-carbon breakthrough scenario, these funds could lose 3-7% of their assets due to exposures to fossil fuel firms. Banks that might suffer relatively large losses include Lloyds Banking Group, Société Générale, BNP Paribas and Standard Chartered. These banks could lose an estimated 0.6-0.8% of total assets on their exposures to oil, gas and coal mining firms. Note that calculations in this report suggest that the largest potential losses for some banks, including Lloyds and BNP Paribas, are in their trading and investment portfolios, not in their corporate loan book. At the national level, the UK and the Netherlands are vulnerable because of the significant exposures of their pension sectors. France is vulnerable due to the high exposure of BNP Paribas and Société Générale.

Assessments by supervisors may reveal further weaknesses

Not all large financial institutions with large potential losses have been identified yet, because the required data for large pension funds from some EU countries and for large insurance companies were not available. The report covered 43 of the EU's largest banks and pension funds. However, due to data limitations, individual insurance companies and some of the EU's largest pension funds could not be included in the analysis. The Thomson ONE database does not include the equity investments of large German pension funds, for example. Furthermore, it was not possible to investigate the trading and investments portfolios of the top 20 banks in a detailed manner. Such assessments can only be carried out by supervisory authorities that have access to all the relevant data and may reveal further weaknesses resulting from concentrated exposures at specific institutions or in specific countries.

More transparency regarding carbon bubble risks is helpful but not sufficient

Transparency regarding exposures to oil, gas and coal mining operations is important because it helps investors and counterparties to assess the risk profile of financial institutions, reducing potential uncertainty in financial markets. In addition, it could stimulate financial institutions to better manage carbon bubble risks. However, it should be realised that more transparency by itself will do little to reduce the vulnerability of EU financial institutions to a sudden carbon bubble shock. At present, pension funds are not being subjected to any meaningful external pressure from supervisors or fund participants to reduce their carbon bubble risks, even if they have large exposures that can readily be identified, as is the case for some UK pension funds. Moreover, pension funds are important investors in banks and insurance companies and they do not feel pressured to manage their own carbon bubble risks, it is unlikely that they will encourage the other financial institutions in which they invest to do so.

Mitigating carbon bubble risks is not the same as promoting green investments

Promoting green investments requires policies other than just mitigating the impact of the carbon bubble on the EU financial system. Reducing carbon bubble risks can be achieved by improving risk perception and promoting active, forward-looking risk management of financial institutions and supervisors. However, mobilising investments in renewable energy, clean technology and energy savings requires an attractive environment for such investments. Given the recent examples of policies that have been reversed in various EU countries, including the withdrawal of subsidies for renewable energy and cleaner cars, the perspective that regulatory risks for green investments are high does not seem exaggerated. Thus, enhancing awareness, risk management and long-term orientation or supervision will be insufficient to promote green investments if the underlying risks and expected returns of such investments remain unchanged.

Recommendations

Adopt clear and effective climate and energy policies

Considering the business rationale for managing carbon bubble risks, it is crucial to reduce uncertainty for financial institutions by adopting clear and effective long-term climate and energy policies. A credible EU policy that provides the necessary long-term certainty to financial institutions will discourage investments in firms holding stranded assets and other high-carbon businesses and, at the same time, boost investments in cleaner technology and energy saving. Reducing uncertainty is also the most effective way to prevent wasteful capital expenditures by fossil fuel firms that increase losses for investors and creditors, reduce market volatility and ensure market liquidity with regard to high-carbon assets, and avoid unnecessary distrust among financial institutions.

Assess carbon bubble risks for all large financial institutions

This report shows that carbon bubble risks differ considerably between individual financial institutions. A further assessment of individual banks, insurance companies and pension funds is warranted to determine the risks in a more detailed manner for all large financial institutions in the EU. The analysis should mainly focus on systemically important financial institutions, but also cover a sufficient proportion of national pension sectors in countries that have relatively large funded (capital-based) pension sectors.

Regarding large EU banks, prudential supervisory authorities should assess whether banks are adequately managing carbon bubble risks in their corporate loan book and take measures if necessary. In non-Euro countries, systemically important banks are supervised by national authorities; in Euro countries, the ECB will take over responsibility for supervising large banks in the course of 2014. The European Banking Authority (EBA) could coordinate a "carbon stress test" and set common parameters for all EU countries. The assessment could involve detailed investigation of corporate loan portfolios, including the types of loans and the companies or projects that are being financed, and the internal risk models used to calculate the capital requirements for such loans.

Regarding large EU insurance companies, prudential supervisory authorities should carry out similar assessments. Insurance companies are largely regulated at the European level via the EU's Solvency regime and supervisors of insurance companies have powers that are comparable to those of banking supervisors. They could therefore also conduct a carbon stress test, which could be coordinated at the EU level by the European Insurance and Occupational Pensions Authority (EIOPA), and impose prudential measures if necessary.

Pension funds, by contrast, are mainly regulated at the national level and EU involvement with pension funds regulation is a sensitive matter. Regulatory frameworks and the powers of supervisory authorities differ considerably from country to country. The focus of supervision is often on pension administration and the management of pension liabilities, that is, calculating the right pension entitlements. Decisions on investment strategies are often left to participants and sponsors. Still, supervisors could assess whether the risk management of individual pension funds is of sufficient quality considering the financial risks associated with the carbon bubble.

As carbon bubble risks extend beyond fossil fuel companies, further research would be needed to better understand the full risks for individual financial institutions and national financial sectors. Such research might be carried out by, for example, the European Banking Authority (EBA), the European Insurance and Occupational Pensions Authority (EIOPA) or the Committee on the Global Financial System (CGFS), as this would help to promote awareness among financial institutions, national supervisors and central banks.

Reduce weaknesses in individual institutions and national financial sectors

If a bank's capital requirements, in relation to its high-carbon exposures, were insufficient to withstand a carbon bubble shock, supervisors could insist on adjustments to internal risk models that raise capital requirements. Note that risk weights should not be used as an instrument to guide lending to or away from certain sectors for reasons unrelated to financial risks, because this would hinder sound risk management practices. In the case of the carbon bubble, however, risk weights could be adjusted to better reflect the real risks associated with loans to fossil fuel

companies, which would enhance risk management. Capital requirements can also be raised via so-called Pillar II requirements, which can be imposed in a discretionary manner by prudential supervisors on top of the basic capital framework.

The regulatory framework for funded pension schemes differs from country to country. However, if pension funds have a large exposure to high-carbon businesses and are not managing carbon bubble risks adequately, national supervisors can usually take measures on the basis of the fiduciary duty of pension funds towards their participants. This fiduciary duty means that pension funds should operate and invest in the long-term interest of their participants. Insufficient management of long-term investment risks, including carbon bubble risks, constitutes a violation of this duty.

In addition, supervisory actions can be taken by national macroprudential authorities (usually the central bank), which are responsible for the stability of the financial system as a whole. Therefore, in principle, they do have the power to ensure that national financial sectors do not have an excessive exposure to carbon bubble risks, so as to prevent the emergence of negative feedback loops that could destabilise the financial system. This could involve reducing the impact of potential shocks to the pension sector as a whole, for example, even if the risks for many individual pension funds do not seem excessive. The EU could call on national macroprudential authorities to use these powers to mitigate carbon bubble risks in national financial sectors.

Impose the separation of investment banking activities on all large EU banks

The vulnerability of banks could be reduced by placing the (significant) investment banking activities of large banks into separate entities with independent funding within the same banking group. The calculations in this report suggest that roughly half of the large banks' carbon bubble risks are in their trading or investment portfolio, not in their corporate loan book. Therefore, insulating commercial banking operations, including corporate lending, from the risks in investment banking activities – such as proprietary trading, the underwriting of equity and bond issues, and significant open positions due to market making – would help to safeguard the stability of commercial banking operations and therefore of the financial system as a whole. The current draft proposal being prepared by the European Commission falls short of achieving this objective.

Internal separation was originally recommended for all EU banks in the October 2012 report of the high-level expert group on reforming the structure of the EU banking sector, chaired by Erkki Liikanen, president of the Bank of Finland. According to the high-level expert group, all EU banks whose trading assets exceed a certain threshold, and for which an assessment by the national supervisor confirms the need for separation, should place their full investment banking activities in a separate entity. The European Commission subsequently held a consultation on the idea of EU-wide separation requirements for banks. As of January 2014, a proposal by Michel Barnier, European Commissioner for Internal Market and Services, is expected shortly. In the draft European Commission proposal, separation is not mandatory but will be left to the discretion of supervisors, which may be under strong pressure to allow exemptions. The proposal also contains a prohibition on narrowly-defined proprietary trading activities for some 30 of the largest banks, but this would not apply to co-operative and savings banks [121]. The latter include Groupe BPCE from France and DZ Bank from Germany, which would suffer estimated losses of 0.2% of total assets in their trading and investment portfolios under a low-carbon breakthrough scenario. The expected draft law should therefore be modified to disallow exemptions and to impose the separation requirements and proprietary trading ban on all large EU banks, regardless of their business model.

Promote active, long-term investment strategies

The EU can promote active long-term investment as a good practice for pension funds. In March 2013, the European Commission published a Green Paper on how to promote long-term financing of the European economy [122], which was followed by a consultation [123]. The Green Paper highlights general constraints to long-term investment behaviour and to the availability of long-term loans and did not focus on climate risks. It identifies asset management intermediation chains as a key factor of short-termism in financial markets. This is due to the short duration of investment mandates and the short-term focus of remuneration schemes for asset managers, which invest on behalf of pension funds,

insurance companies and other asset owners. The Green Paper also notes the potential negative influence of fair value accounting, which focuses on the current market value of assets regardless of whether this properly reflects their long-term intrinsic value. The Green Paper does not contain clear policy proposals to address these problems. The Kay review of investment horizons in UK equity markets, published in July 2012, identifies similar issues and recommends that asset management firms should provide long-term performance incentives to their investment managers, in line with the timescales of their clients [124]. However, there exist major obstacles at the level of asset owners as well. Currently many pension fund boards have a short-term investment horizon as they are under pressure to avoid pension cuts. As a consequence, they seek to maximise short-term returns that improve the present funded status of the fund instead of pursuing long-term strategies.

As pension funds are mainly regulated and supervised at the national level, the EU might play a coordinating role in stimulating investment on the basis of long-term strategies. It could also help to raise awareness and promote good practices. Promoting long-term active investment, as opposed to passively following a benchmark index without considering long-term risks associated with that benchmark, will be conducive to better management of carbon bubble risks. This also applies to insurance companies. Note that investors can use different types of active investment strategies. They can adjust their exposure to entire sectors, such as oil and gas. They can also choose to invest in the most sustainable firms within a particular sector, or exclude the least sustainable firms. Asset owners should bring investment mandates for asset management firms in line with such strategies to address intermediation chain problems. They should incorporate explicit long-term objectives and long-term incentive structures for fund managers in their investment mandates.

For pension funds and insurers that continue to passively invest in equity and bond indices, or that use quantitative investment management approaches that do not consider underlying fundamentals, the EU can promote low-carbon indices or joint high-carbon exclusion criteria. This could help institutional investors that are reluctant to fundamentally revise their investment strategy to opt for an easy alternative that also reduces carbon bubble risks. The promotion of joint exclusion criteria, rather than fund-specific criteria, would help to generate more market pressure on high-carbon firms that are excluded from market indices to stop investing in potentially stranded assets.

The EU can also promote engagement of institutional investors with fossil fuel companies with the aim of reducing risks at the level of the oil, gas and coal companies instead of at the level of the investor. Institutional investors could insist on testing the viability of new projects against a low-carbon scenario, which may strongly reduce new capital expenditures related to stranded assets, and put pressure on fossil fuel firms to diversify into renewable energy, if possible.

Include specific reporting requirements in the EU Accounting Directive

Mandatory reporting on climate risks could enhance awareness among financial institutions and stimulate better risk management. Moreover, it could help to prevent unnecessary distrust and stigmatisation of financial institutions regarding the size of high-carbon exposures and potential losses. Mandatory reporting should ideally cover the risks of a transition to an environmentally sustainable economy for high-carbon businesses as well as the risks associated with severe climate change. Various initiatives already exist to enhance reporting at the global level, including the 2 Degrees Investing Initiative and the Greenhouse Gas Protocol. Therefore, the EU does not need to develop new reporting methods, but should specify what issues must be covered in annual reports. This approach fits well with the EC proposal, on 16 April 2013, for a Directive establishing a legal obligation for companies to disclose environmental, social and diversity information (COM(2013)207) [125]. The proposed directive would add to the new Accounting Directive (2013/34/EU) a requirement to report on environmental matters, including related company policies, results, risks and risk management. Companies can rely on existing frameworks for compiling and presenting this information.

However, the proposal needs to be improved. The current proposal does not refer in any way to greenhouse gas emissions or climate change. Considering the importance and specific nature of the issue, a general reference to environmental matters will be insufficient. Instead, the directive should include a specific requirement to report

on current and potential future greenhouse gas emissions and climate change-related matters. Furthermore, the proposed directive does not contain special reporting guidance for financial institutions. Without such guidance, the reporting requirements may be interpreted as applicable to their own operations only, such as the greenhouse gas emissions of their offices (Scope 1 emissions in Greenhouse Gas Protocol terminology). The directive should explicitly prescribe that, for financial institutions, the reporting requirements apply also to their financial assets. In other words, it should be mandatory for financial institutions to report on relevant policies, results, risks and risk management strategies regarding their investment, credit, and trading portfolios. Similarly, for fossil fuel firms, the reporting requirements should not only cover the greenhouse gas emissions of their own production and exploration processes, but also explicitly apply to the impacts of their fossil fuel reserves.

Prevent the shifting of carbon bubble risks around the financial system

The EU and financial supervisors should monitor the shifting of carbon bubble risks. Carbon bubble risks can be shifted but can not be made to disappear from the global financial system. If EU pension funds, banks and insurance companies reduce their carbon bubble risks, the stability of the EU financial system increases. In addition, such a shift would probably impact financial markets and reduce the value of the securities of fossil fuels companies, because the appetite for such investments would decrease. This would put some pressure on fossil fuel firms to reconsider their business models and reduce investments in potentially stranded assets. However, the securities and the risks associated with them will not go away, they will be passed on to other investors. If these are wealthy private investors (or speculators) that are better able to absorb losses without causing shocks to the financial system, this is a good thing. However, if the assets were to be bought, for instance, by hedge funds, then institutional investors might end up with lower carbon bubble risks in their normal equity and bond portfolios, but higher carbon bubble risks in their hedge fund investments. Such shifts would do little to mitigate potential shocks to the financial system and should therefore be carefully monitored and addressed if necessary.

Methodological limitations

The estimates in this report are conservative as it is not possible to analyse all relevant equity and corporate bond holdings. Due to the vast amount of data it is possible that some relevant high-carbon companies have not been identified. The value of equity holdings covered in financial databases often does not represent 100% of pension fund shareholdings. For example, investments in private equity funds are not included in detail. The actual high-carbon share of these investments is difficult to estimate, as certain index funds or funds of funds could hold a considerably higher-than-average share of oil, gas and coal mining companies depending on their investment strategy. The assumption that the share of high-carbon companies in corporate bond holdings is the same for all pension funds means that this share may be overestimated or underestimated for individual pension funds.

When interpreting the figures for the exposure of banks, it is important to consider that the analysis of loans is limited to industries directly involved in the extraction of fossil fuels but does not cover industries which are involved in downstream activities such as the trading of fossil fuels or the production and sale of energy from fossil fuel feedstock, for example. These companies as well as many other downstream industries are also heavily exposed to the carbon bubble.

In addition, the coverage of loans to the analysed industry sectors is not complete. Firstly, only syndicated loans are included in financial databases and coverage is not equally good for all countries. Secondly, relevant loans may not all be recognised due to erroneous categorisation or categorisation in a different industry sector due to diverse business activities. Thirdly, the value of the banks' participation in the loans is based on estimates which may be too low. Considering the fact that the analysed banks are among the largest in the world, their role in syndicates may be larger than the estimated equal distribution within the different roles.

On the other hand, considering revolving credit facilities as outstanding values may exaggerate the actual exposure to high-carbon assets as it cannot be predicted whether these credits will actually be drawn down or not. However, this approach was chosen as it better reflects the potential maximum exposure, and therefore the actual risk the banks are facing.

Fossil fuel-related investments in private equity and infrastructure cannot be considered in the estimates due to a lack of information. In some cases these assets may account for another couple of percentage points.

The approach taken is based on the best available data and provides a conservative estimate of the total investments and potential resultant risks for European pension funds and banks. We believe the dataset to be of sufficient quality and geographical distribution to allow for a solid estimate of the overall exposure of these financial institutions. Due to a lack of detailed data, insurance companies cannot be included in the detailed analysis at this stage, even though they do play an important role as institutional investors.

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After the real estate and dot-com bubbles, are we witnessing the emergence of a new one: a carbon bubble? This term refers to the overvaluation of the fossil fuel reserves by financial institutions who are failing to take climate change and its policy consequences into account, and is the subject of the latest publication in GEF's Green New Deal series.

This study, commissioned by the Greens/EFA Group in the European Parliament and conducted by the research organisations Sustainable Finance Lab and Profundo, begins by estimating the scale of the challenge. What is the exposure of the different European financial institutions and how resilient would the system be to a "carbon shock"?

The study raises serious questions about the exposure of the financial sector to this risk. It identifies the EU Member States and individual banks and pension funds that are particularly vulnerable. But it also examines some of the exit paths from a carbon bubble. A decisive transition to a low-carbon economy can help us avoid a "carbon shock" in a cost-effective manner, and would ensure certainty for the global economy. With the continued fragility of the Eurozone financial sector, this is urgently required.

The study also examines an "uncertain transition" scenario. This comes to the conclusion that weak energy and climate targets – as proposed by the European Commission for 2030 – would end up having the highest costs for the financial industry. With this, the study clearly outlines the carbon bubble impact on the EU and the price of doing too little too late.

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