

STUDY

Requested by the ECON committee



Financial institutions' exposures to fossil fuel assets

An assessment of financial stability
concerns in the short term and in the
long run, and possible solutions



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Abstract

Many financial institutions have warned that the transition to a low-carbon economy could cause a major shock to fossil fuel valuation, with the potential for systemic risk. This paper discusses disclosure commitments and empirical evidence in order to gauge the exposure of banks towards fossil fuel assets as well as the consequent implications for banks' balance sheets and for financial stability.

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LIST OF ABBREVIATIONS

BIS	Bank for International Settlements
CCPI	Climate Change Performance Index
CDP	Carbon Disclosure Project
CPE	Climate Policy Exposure
CRR	Capital requirements regulation
CSRD	Corporate Sustainability Reporting Directive
EBA	European Banking Authority
ECB	European Central Bank
ESG	Environmental, Social, and Governance
FCA	Financial Conduct Authority
FSAA	Financial Sector (Climate-related Disclosures and Other Matters) Amendment Act
FSB	Financial Stability Board
IEA	International Energy Agency
ITS	Implementing Technical Standards (ITS)
IPCC	Intergovernmental Panel on Climate Change
GFANZ	Glasgow Financial Alliance for Net Zero
NFCs	Non-Financial Corporates
PCAF	Partnership for Carbon Accounting Financials
PRA	Prudential Regulation Authority
RWA	Risk-weighted assets
SBTi	Science Based Targets initiative
SDS	Sustainable Development Scenario
SIC	Standard Industrial Classification
TCFD	Task Force on Climate-related Financial Disclosures
TECs	Transition-Exposure Coefficients
TECV	Transition Energétique et Croissance Verte (Energy Transition and Green Growth)
WCPE	Weighted Climate Policy Exposure

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EXECUTIVE SUMMARY

This paper examines the fossil fuel exposure of banks, the sources of information available to assess it, the underlying key factors that drive it, as well as the consequent implications for bank balance sheets and for financial stability. As climate policy becomes more stringent on the pathway to net zero carbon emissions, the majority of fossil fuel firms' oil, gas and coal reserves may never be extracted because doing so would intensify global warming. The loss of value will directly affect shareholders, investors and investment funds, but it may also particularly affect banks that provided loans to those companies or have other direct exposures which in turn could be a cause of financial stability concern. Banks' overall exposure to fossil fuel is composed of both direct exposure – loans for and investments in operations and companies associated with extracting, producing, and investing in fossil fuels – as well as indirect exposures – loans and investments in companies that themselves have exposure to fossil fuel investments.

This paper first reviews the sources of information available to assess the exposure of banks to fossil fuel in their balance sheets and investment portfolios. A possible barrier for moving credit flow away from fossil fuels and for the public to intervene is the lack of information on bank exposures to the risk that fossil fuel reserves may become stranded. An analysis to what extent that information can be extracted from sources of mandatory disclosure reveals that challenges related to lack of data and assessment methods hinder accurate monitoring and mapping of banks' exposures to risks associated with stranded assets. Reporting on climate change risk under consideration of carbon risk is gaining traction, with ever more implementations triggered by voluntary disclosure commitments and recent steps towards government mandated reporting requirements. Despite this, reports show that there is still a lack of substantial disclosure by banks.¹ Banks and other financial institutions need to be moved towards transparent disclosure and improved global standards on carbon accounting practices, so that one can measure their progress towards net-zero in a meaningful manner.

This paper further provides insights into the aggregate and bank-specific fossil fuel exposure and consequent risk in Europe, based on a literature review and new own calculations. Banks should be able to properly assess and price this risk when lending to fossil fuel firms. Furthermore, redirecting credit away from fossil fuel is crucial to reaching climate goals. However, recent reports indicate that overall banks' direct financing of fossil fuel firms has not decreased either. With regards to the intensive margin; the stranded asset risk of the fossil fuel firms for which large banks provide financing appear to be gradually increasing while banks do price stranded asset risks only saliently or less relative to markets.²

Recent research allows insights into potential trends of bank credit flows and their implications as a result of the climate transition as well as into possible approaches to mitigate banks' continued fossil fuel exposure. It is suggested that some banks are willing to replace lost capital market funding in the context of increased climate policy risk. Complementary research indicates that banks increase their cross-border lending in response to a greater climate policy stringency in their home country, if the home country has a more stringent climate policy than the borrowers' countries; policy makers therefore have to reflect on how to best limit regulatory arbitrage.³

¹ See the ECB report on banks' progress towards transparent disclosure of their climate-related and environmental risk profiles. Also discussed in chapter 2 of this paper.

² "Extensive margin" refers to "how much do banks invest in fossil fuel". "Intensive margin" refers to "how risky are the fossil fuel investments, on average".

³ See Beyene et al. (2021), Delis et al.(2021), and Benincasa et al. (2021) in chapter 4 of this paper.

While the immediate loss for banks in the Europe from direct fossil fuel exposure is relatively contained, there are large indirect exposures via financial interlinkages. Once climate stabilisation begins, fossil fuel firms may have little to no time before suffering economic losses in terms of both income and wealth, which naturally translates into credit risk for financial institutions. In any case, a "too-late-too-sudden" transition is recognised to cause the largest losses for financial institutions and also imply a greater risk of financial stability. A sudden, unexpected tightening of carbon emission policies would not only lead to an economic shock due to large swings in asset prices, but the situation would be amplified by second-round effects in financial markets.⁴

⁴ See Drudi et al (2021) and Stolbova et al. (2018) in chapter 5 of this paper.

1. INTRODUCTION

To achieve the Paris Agreement target of limiting global warming to 2°C or less, a significant portion of the world's oil, gas, and coal reserves will need to become stranded. “Stranded assets” are assets at risk of becoming obsolete from “*unanticipated or premature write-offs, downward revaluation or being converted to liabilities due to regulatory or environmental changes*”.⁵ Throughout the existing literature a strong evidence for a link of climate change and financial risks is visible. Therefore, banks and other financial institutions have to adjust their balance sheets and investment portfolios in line with the trajectories of the energy transition. This risk of fossil fuel reserves becoming stranded assets is primarily politically determined through restrictions on fossil fuel extraction, carbon pricing, subsidy regimes, etc. However, there are several other factors that can lead to stranding, on the forefront being technological changes or sudden price changes in fossil fuel resources.

Fossil fuel stranded assets of companies - e.g., coal mines, oil fields, and gas reserves or their exploitation rights - are a cause of concern for financial institutions. The risk of these assets becoming stranded likely would translate into credit and liquidity risk for banks that lend to fossil fuel businesses, and other financial institutions that invest in these businesses. Financial exposure to the fossil fuel industry for financial institutions and the potential impact and economic cost of climate policies on the financial system have already been the subject of much discussion and many have warned that an abrupt and coordinated increase in carbon prices could cause a major shock to fossil fuel valuation, with the potential for systemic risk.

Thus, the climate transition is a credit risk concern for banks and they have to consider the risk derived from fossil fuels when taking investment decisions and in their credit-granting processes. Thereby they could play an important role in terms of channelling funds away from fossil fuels and polluting type of activities and invest in activities that would be greener. But particularly banks may not always play this beneficial role and the lack of pricing of transition risks may lead to credit allocation that is not aligned with sustainable development. Recent research shows that financing for fossil fuel firms by international banks has not decreased since the Paris Agreement was adopted in 2015 and that international banks continue to provide financing to fossil fuel firms regardless of their stranded asset risk.⁶

Against this backdrop, this paper aims to evaluate financial institutions' exposures to the fossil fuel industry and derives implications for financial institutions credit risk and financial stability concerns. Figure 1 provides an overview of the chain in which financial risk as a result of the impact of climate policy on fossil fuels travels through. We focus on the potential impact of the decline in asset values across the fossil fuel sector which may trigger lower corporate profitability and higher probability of default and lower collateral value.

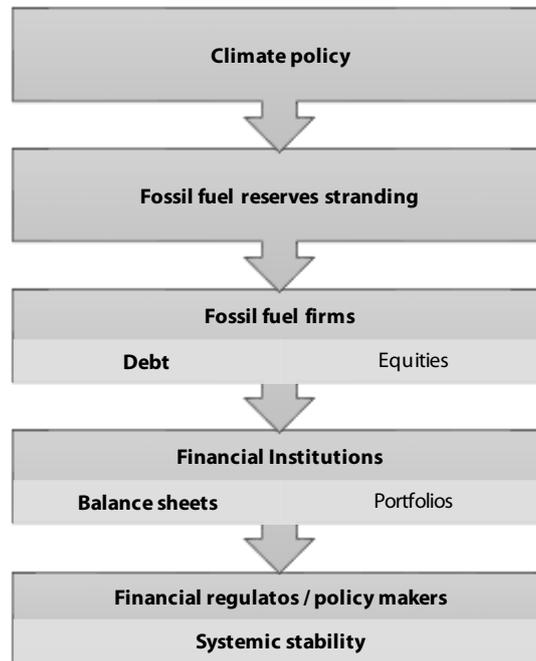
The paper proceeds as follows. The next section sets out to discuss sources of information that are available to gauge the exposure of banks and other financial institutions towards fossil fuel companies. Paramount in this whole discussion on the financial sectors fossil fuel exposure is the possible lack of information on bank exposures to the risk that fossil fuel reserves may become stranded. In chapter 3, to quantify the vulnerability of European banks, their direct and indirect share of exposure to fossil fuel firms is evaluated. The extent to which the stranding of fossil fuels will negatively impact banks

⁵ As defined by Caldecott et al. (2013, p. 7).

⁶ According to recent reports, international banks have financed fossil fuels with USD 3.8 trillion (all financing activity, including underwriting) since the Paris Agreement was adopted (2016–2020) (Rainforest Action Network, 2021). Beyene, Greiff, Delis, & Ongena (2021) show that banks continue to provide financing to fossil fuel firms that the bond market would not finance as long as they do not price the risk of stranded assets. Hence, stranded assets risks may have shifted onto the balance sheets of large banks.

depends on how well fossil fuel exposure is integrated into prices, hence we ask next the question; are stranded assets risks accounted for in prices? In chapter 4, recent research on potential reasons underlying continued fossil fuel investments by banks as well on various patterns of credit flows in the context of climate policy emergence is discussed. Chapter 5 sets out to discuss the materialisation of stranded assets and consequent financial stability impact in the short and long-term. In chapter 6, we present concluding remarks.

Figure 1. Fossil fuel exposure chain



Source: own illustration based on Curtin et al. (2019).

2. INFORMATION SOURCES FOR BANKS' FOSSIL FUEL EXPOSURE

Climate change risk disclosure is seen as one of the main instruments to strengthen the global response to the threat of climate change. A robust and transparent reporting of banks institutions' exposures to fossil fuels is expected to promote market transparency and discipline as well as allow for improved data collection needed for regulatory and empirical work.⁷ This is because disclosure on fossil fuel exposure provides market participants and the public with the information they need to make meaningful assessments of a bank's credit risk profile. Transparency in this area is particularly important since a significant cause of bank failures and banking crisis is poor credit quality and deficient credit risk assessment and measurement practices.⁸

According to the Bank for International Settlements (BIS) the majority of its members consider it appropriate to address climate-related financial risks within their existing regulatory and supervisory frameworks, hence, the need for sound disclosure on material climate-related and environmental risks is recognized as a supervisory priority.⁹ The European Central Bank (ECB) has formulated expectations with regards to banks' disclosure in non-binding guidelines on climate-related and environmental risks that have been first published in 2020.¹⁰ Among other things, the expectations would imply that banks consider fossil fuel exposure risks in their risk appetite framework and when granting credits and monitoring portfolio risks. Furthermore, institutions are expected to publish meaningful information and key metrics on fossil fuel risk exposures. The ECB recently conducted a supervisory review of how banks implement the recommendations and disclose climate-related risks.¹¹ It revealed that, two years after the publications of the guide, banks fall short of expectations and their climate-related and environmental risk disclosures are lacking of substantial quantitative and qualitative information. This is despite more banks formally reporting on climate-related risks and opportunities.

Formative for banks' disclosure practices have been several climate change-related disclosure initiatives.¹² A distinction is made between mandatory and voluntary disclosure commitments. The most established voluntary climate disclosure initiative within which scope fossil fuel exposure would fall and that has somewhat become a global standard for non-financial and financial organizations equally is the Task Force on Climate-related Financial Disclosures (TCFD).¹³ The TCFD provides for corporations since 2017 a framework for assessing and reporting on their climate-related risk management strategy and an addendum offers supplemental guidance for the financial sector (Task Force on Climate-related Financial Disclosures 2017). The framework suggests that banks provide the

⁷ See for example "Chapter 15: Investment and finance" of the 2022 IPCC report (Kreibiehl et al., 2022).

⁸ See the BIS's general guidance on credit risk assessment, disclosure and management, for example Basel Committee on Banking Supervision (1999, 2015).

⁹ Based on the BIS's stocktake of its members initiatives on climate-related financial risks (2020). Data availability on climate-related exposure is particularly relevant for dedicated climate stress tests that may be applied to evaluate the impacts of plausible environmental scenarios on, portfolios, institutions, and even financial markets as a whole. Such stress tests would also contribute to the safety and soundness of the financial system as the outcome may ultimately inform supervisory actions. For example, the European Central Bank is running an economy-wide climate stress test, which has been developed to assess the resilience of non-financial corporates (NFCs) and euro area banks to climate risks, under various assumptions in terms of future climate policies (Alogoskoufis et al., 2021).

¹⁰ The ECB guidelines are consistent with the non-binding "Guidelines on non-financial reporting: Supplement on reporting climate-related information" (2019/C 209/01) from the European Commission; are based on proposals from Technical Expert Group (TEG) on Sustainable Finance; integrate the recommendations of the TCFD; and went through public consultation (European Central Bank, 2020).

¹¹ The ECB's updated assessment covered 109 directly supervised banks and focused mainly on disclosures at the highest level of consolidation. Supervisors analysed banks' most recent public information available by 1 November 2021 as well as documents that were part of the ECB's 2021 climate risk self-assessment exercise (European Central Bank, 2022).

¹² Appendix B provides an overview of banks' main fossil fuel mandatory disclosure commitments as of today.

¹³ The G20 Financial Stability Board (FSB) implemented the TCFD in 2015 with the mandate to develop climate-related disclosures that "would enable stakeholders to understand better the concentrations of carbon-related assets in the financial sector and the financial system's exposures to climate-related risks" (Task Force on Climate-related Financial Disclosures, 2017).

metrics used to assess the impact of climate-related risks on their lending and other financial intermediary business activities and the amount and percentage of carbon-related assets relative to total assets¹⁴. The adaptation of the TCFD recommendations by banks however, invokes criticism due to the overall lack of disclosure of meaningful information. Bingler et al. (2021) apply a deep neural language model that is specialised on finding information about climate risk in corporate reports and documents to analyse companies' climate-risk disclosures within the four main TCFD categories framework. By applying their model to the annual reports of more than 800 companies from different sectors that support TCFD, they show that the announcement of TCFD support does not result in materially increased disclosures. The average amount of climate risk reporting increased only slightly by approximately 1.9 percentage points after the launch of the recommendations in 2017 until 2020. The ineffectiveness in TCFD reporting is further exposed by the observation that disclosures on strategy and metrics and targets, are particularly lacking. Fossil fuel exposure disclosures do not conform to a common set of standards — within the TCFD, key metrics used to measure and manage climate-related risks are at the discretion of the reporting banks. Hence, this reporting practice does not allow for an assessment over time and against peers and complicates accurate monitoring and mapping of the financial system' exposure to stranded assets risks. Looking at large European banks that are TCFD signatories and that do report at least one carbon-related metric, further reveals that reporting on financed emissions often does not cover scope 3 financed emissions¹⁵ in a sufficient manner and barely ever includes the percentage of carbon-related assets.¹⁶ More importantly, reporting does not cover banks whole lending or investment portfolios nor other financial intermediary activities. Due to the lack of a consistent methodology as well as sufficient disclosure on the individually used methodologies across banks, it is difficult to derive banks' exposure to the fossil fuel sector and ultimately map banks' exposure to stranded assets based on the carbon-related metrics disclosed.¹⁷

Voluntary disclosures are not sufficient as companies may be less forthcoming with bad news. It is therefore promising that recent developments indicate a trend towards mandatory disclosures of climate change-related financial risks. The example of the introduction of the Article 173-VI of the French TECV law that imposes more stringent climate-related disclosure standards on institutional investors – however not banks – shows that the imposition of climate-related disclosures is in fact leading financial institutions that are affected by the law to divest of these carbon-intensive assets relative to French banks and other institutions.¹⁸ However, the principle of comply-or-explain provides investors with broad flexibility, and as a result, many institutional investors are found to not meet expectations for reporting changes.¹⁹ Although the principle of comply-or-explain may lead to more efficient governance outcomes where the ability to report on climate-exposure is dissimilar among firms, the approach also poses challenges for implementation. In recent years, more regulatory efforts have been emerging that encourage or even mandate climate-risk disclosures. For example, the UK is

¹⁴ The TCFD recognises that the term carbon-related assets is not well defined. Entities need to use a consistent definition to support comparability. The TCFD suggests defining carbon-related assets as those assets tied to the energy and utilities sectors under the Global Industry Classification Standard, excluding water utilities and independent power and renewable electricity producer industries change in 2021 (Task Force on Climate-related Financial Disclosures, 2021).

¹⁵ In principle, financial institutions themselves generate little or no GHG emissions in their day-to-day business. A focus on scope 3 emissions reporting by financial institutions with regard to the fossil fuel sector is much more material in the context of assessing risks.

¹⁶ Overview of banks that support TCFD can be found here: <https://www.fsb-tcfid.org/supporters/>

¹⁷ Methodologies differ in the scope of information, for example with respect to whether subsidiaries are included, what kind of assets and companies are covered, how granular the metric is by region or counterparty sector etc.

¹⁸ Mésonnier and Nguyen (2021) examine whether the introduction of the Article 173-VI of the French TECV law that imposes more stringent climate-related disclosure standards on institutional investors – however not banks – actually leads them to divest from carbon-intensive securities and show that the imposition of climate-related disclosures is in fact leading them to divest of these carbon-intensive assets.

¹⁹ An overview of the Article 173-VI of the French TECV law disclosure implementations after two years can be found in Evain et al. (2018).

to enforce on a comply-or-explain basis mandatory TCFD reporting from 2022 on for large companies. Other jurisdictions that have undertaken steps towards mandatory disclosure requirements that leverage the TCFD framework include the European Union, Brazil, New Zealand, and Switzerland.

An important step towards closing the fossil fuel information gap in the EU is the European Banking Authority's final draft Implementing Technical Standards (ITS) on Pillar 3 disclosures on ESG risks, published in January 2022. This prudential reporting requirement will affect large financial institutions in all of the EU Member States falling under the capital requirements regulation (CRR).²⁰ Following the ordinary legislative procedure to become binding EU law, the rules are expected to apply not earlier than 2025. With regards to banks' fossil fuel exposure the ITS requires the binding disclosure of specific indicators based on tables, templates, and associated instructions for banks' lending portfolios. The ITS will shed new light on banks fossil fuel exposure and the disclosure and standardized presentation of this new information will allow for major steps towards comparable reporting of material information.²¹ Most noted data gaps with the ITS reporting are that the templates cover only core banking books which include loans but not trading book assets like stocks and bonds. Sovereign fossil fuel exposures are not included and it only applies to the largest listed EU banks. The level of detail with regards to methodology which allows banks to opt for different approaches imposes limitations to peer benchmarking.

Financial institutions have recently started to coordinate in order to commit to align collectively their lending and investment portfolios with net-zero emissions by 2050. The Glasgow Financial Alliance for Net Zero (GFANZ), chaired by Mark Carney, UN Special Envoy on Climate Action and Finance, unites – as of November 2021 - 450 financial institutions from the leading net-zero initiatives across the financial system.²² With these high-profile initiatives, it has become more difficult for financial institutions to not address climate-related risks. However, support for these alliances does not translate to improved disclosure of relevant climate-related data. Moreover, net-zero alliances and as well as current disclosure initiatives do not dictate or specify what needs to happen in the fossil fuel sector. Looking at actual disclosures by banks, in the context of these wide ranging commitments to net-zero across governments and financial institutions, regulators could require that banks estimate and report their carbon pathways and their alignment with net-zero targets over the years.²³

²⁰ Article 434a of Regulation (EU) No 575/2013 (CRR) mandates the EBA to develop implementing technical standards (ITS) on the disclosure of prudential information on ESG risks by large institutions, as specified in Article 449a CRR.

²¹ With regards to information of banks' fossil fuel exposure, these three quantitative templates on banks book information are the most relevant (European Banking Authority (EBA), 2022):

- Credit quality of exposures by sector, scope 3 emissions and residual maturity. Banks are required to disclose their exposures to "sectors that highly contribute to climate change", as specified in the EU's Climate Benchmark Standards Regulation. It further asks them to single out the amount of exposures in each sector that are "towards companies excluded from EU Paris-aligned Benchmarks" — meaning those particularly harmful to the climate.
- Banks' scope 3 emissions based on the counterparty's sector and on alignment metrics defined by the International Energy Agency (IEA) for different sectors. Banks are required to estimate the distance from the current value of the alignment metric to the 2030 projection according to the IEA's Net Zero Emissions by 2050 scenario.
- Banks' exposures to the top 20 carbon-intensive companies in the world, including the average maturity of the exposures. Banks themselves can identify the top 20 most carbon-intensive companies in the world, however, relying on public available information. The EBA suggests as potential data sources Carbon Majors Database of the Carbon Disclosure Project or Thomson Reuters.

²² See more on GFANZ here <https://www.gfanzero.com/progress-report/>. Banking Alliance: <https://www.unepfi.org/net-zero-banking/>

²³ E.g. suggested by Bolton et al. (2021).

3. EXPOSURE TO THE FOSSIL FUEL INDUSTRY

3.1. Role of Banks in the Climate Transition

The primary role of the financial sector in the economy is to mobilize resources for productive investment. In the context of the climate transition, capital investment decisions are critical in shaping the nature and pace of the climate transition and the role of the financial sector is central to the process. Their economic function foresees that banks and other financial institutions via debt markets would play a major role in cutting debt financing in downsizing carbon-intensive sectors, and in providing new credit to finance investment in expanding, innovative and green technology sectors. By not accounting for the risk of stranded assets and other transition risks, the financial sector itself may become a source of misallocation.

An emerging string of literature examines the interaction between climate transition and bank lending. While favorable credit conditions may lead to higher investments into pollution abatement and thus lower toxic emissions²⁴, literature also suggests that banks are less likely to finance innovation as it is more efficient for them to acquire information on mature technologies compared to newer technologies.²⁵ Banks with legacy positions are inherently technologically conservative which may be to some extent related to the potential of new technologies to reduce the value of assets already on banks' balance sheets.²⁶ Consequently, mature and capital-intensive endeavors, like fossil fuel procurement, may face less external financial frictions than green technology. In fact, banks have traditionally been large lenders to the fossil industries. This, combined with the fact that the fossil fuel industry is very capital-intensive and requires financial resources for its operations, substantiates a big impact that the banking sector may have on future fossil fuel procurement. Financial markets and banks can differ in the way they reallocate credit across and within different industries. Carbon-intensive industries may reduce emissions faster in economies with deeper stock markets as opposed to debt markets.²⁷ This suggests that the aggregate composition between market-based and bank-based finance in a financial system likely matters for the financing of fossil fuel industry, and consequently, the level of industrial pollution caused by an economy.

From a theoretical perspective, banks - as efficient allocators - should account for transition risk in their lending policies which expectedly should be reflected in a shift away from risky fossil fuel firms. However, we have also presented an excerpt of research on why banks may not be conducive to "green" innovation but also be locked-in with fossil fuel investments. In the following section, we present estimates on the current level of exposure of the banking industry to the fossil fuel industry, aggregated for banks in Europe. We further look into whether and how banks account for the risk of stranded fossil fuel assets.

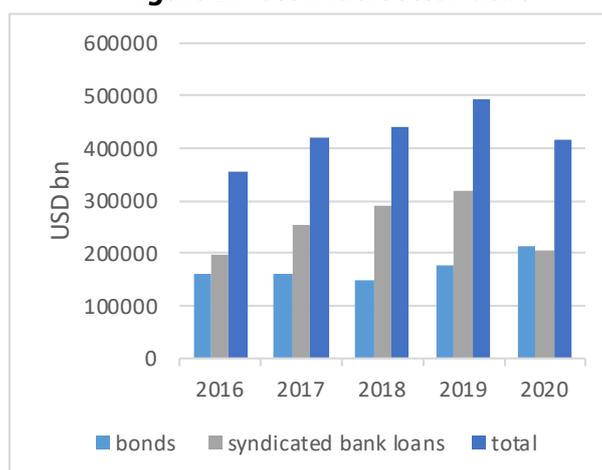
²⁴ Exploiting spatial variation in credit constraints, De Haas et al. (2021) analyse how credit constraints may inhibit corporate investment in green technologies. Goetz (2019) and Levine et al. (2019) show that more favorable funding conditions lead firms to reduce their toxic emissions or vice versa.

²⁵ Brown et al. (2017) show that banks are found to be technologically conservative and hesitant to invest in intangible capital. Ueda (2004) further shows that banks might also lack the skills to assess and monitor new green technologies.

²⁶ See for example Minetti (2011).

²⁷ In a recent paper, De Haas and Popov (2020) analyse the mechanisms that connect the structure of the financial system and the degree of environmental degradation. They find that, for given levels of economic and financial development, carbon emissions per capita are significantly lower in economies where equity financing is more important relative to bank lending.

Figure 2. Fossil fuel sector debt



Source: Own illustration based on Dealscan syndicated bank loan and Thomson Reuters corporate bond data

3.2. Aggregate Exposure to the Fossil Fuel Sector

Fossil fuel companies have experienced an increase in debt financing these last two decades and represent a significant fraction of the non-financial corporate sector. The increase of total oil and gas borrowing is estimated to have been approximately 15% annually in the period from 2006 to 2014.²⁸ And even after the Paris Agreement was adopted in 2015, syndicated bank loan and bond financing to the fossil fuel sector are higher in 2020 than what they were in 2016. Figure 2 illustrates the total syndicated bank loans and corporate bonds provided to the fossil fuel sector²⁹ from 2016 to 2020.³⁰ Given that a substantial part of the global stock of carbon-assets is financed by debt, a sudden reevaluation of carbon assets could potentially risk financial institutions investments and propagate systemic risk seems reasonable. This ongoing fossil fuel debt financing requires an appropriate assessment of the total exposure of the financial system to fossil-fuel-reserves.

3.2.1. Direct Exposure

The financial exposure to the fossil fuel sector for financial institutions and the potential impact and economic cost of climate policies on the financial system has been already widely discussed.³¹ Banks' overall exposure to fossil fuel is composed of both direct exposure – investments in operations and companies associated with extracting, producing, and investing in fossil fuels - as well as indirect exposures - investments in companies that themselves have exposure to fossil fuel investments.

²⁸ Domanski et al. (2015) explored the interaction between oil prices and high debt levels of oil companies and also assess the debt burden of the oil and gas sector.

²⁹ We classify a firm to be in the fossil fuel sector if it has a Standard Industrial Classification (SIC) between 1200-1400. See Appendix C.

³⁰ To proxy the total global debt issues of the fossil fuel sector we aggregate corporate bond issues collected from Thomson Reuters and syndicated bank loans collected from Dealscan. In 2020 we observe a decrease in syndicated bank loans and an increase in corporate bonds, implying that the total volume of syndicated bank loan was surpassed that year by corporate bonds. In the early stages of the pandemic, in 2020, syndicated bank loan financing, particularly cross-border, fell while corporate bond issuance experienced an increase. A small but expanding literature on the effects of COVID on the banking system suggests that corporate bond issuance was used to increase holdings of liquid assets as market funding was more accessible than bank debt (see e.g. Beck & Keil, 2022; Pascual González, 2021). This could be a likely explanation for this observation in 2020, however requires more analysis.

³¹ See for example Carney (2015) and Drudi et al. (2021).

Several efforts have been undertaken to estimate the exposure not only on an individual company-level but also on an aggregate economy-wide level based on external data. To calculate the fossil fuel exposure of the banking or other financial institution sector on an aggregate level, information on the share of the fossil fuel sector for each asset class is required. One approach is to derive this information from individual financial institutions balance sheets. Weyzig et al. (2014) estimate that the exposure of European financial institutions to fossil fuel firms via loans, bonds and equity exceeds EUR 1 trillion.³² Battiston and Stolbova (2020) estimate that the combined exposure of banks, insurance and pension funds, and investment funds to the fossil-fuel sector is relatively small at about 1.5% of all assets for all EU Area Institutions. Additionally, their calculations indicate that direct exposure to fossil fuels is concentrated within loans and bonds for banks, while equity exposures to fossil fuels are much higher within pension funds and investment funds.³³ Supervisory data is more reliable and provides more information on securities on an aggregate level held by specific euro area investors, broken down by instrument type, issuer country and further classifications. Alessi and Battiston (2021) using confidential security-by-security databases estimate the level of exposure to high transition risk of banks, which includes a subset of the climate-relevant sectors which have large dependence on fossil fuel, to be at 1.7% for banks, 5% for insurers and 6.1% for investment funds.³⁴ While the relative direct fossil fuel exposure is relatively contained, financial interlinkages can result in significant indirect exposures.

3.2.2. Indirect Exposure

In the course of large-scale writing-offs of fossil fuel assets, interconnectedness in the banking system will create additional systemic risk on top of the incorporation of the reevaluation of fossil fuel assets. A valuation adjustment in debt securities along a chain of counterparties in a network of interbank loans, banks' loans to other corporate and retail clients, and securities holdings with fossil fuel links, can result in reinforced impacts on banks' balance sheets. Moreover, if banks continue to price fossil fuel exposure too low, feedback effects from deleveraging in common fossil fuel asset holdings may amplify the initial shock of large fossil fuel writing-offs. A common shock to fossil fuel asset prices may trigger fire sales of assets of fossil fuel companies and related companies which further depresses price, which means fossil fuel companies have lower debt carrying capacity. An increasing devaluation of fossil fuel assets then reduces the value of investments, and increases risks to lenders and other financial market participants. Furthermore, the possibly widespread impact of climate change beyond the fossil fuel sector, for example on energy-intensive firms indirectly affected by an increase in fossil fuel prices or sectors affected by the materialization of physical risks, may further lead to pro-cyclicality

³² Weyzig et al. (2014) ballpark the exposures of the EU banking sector by extrapolating the share of fossil fuel investments (investments in listed shares of oil, gas and coal producers) from available data from an investment analysis for selected groups of banks across the relevant sectors in the EU. The informative value of their analysis is limited by a lack of transparent information, particularly with regards to bond holdings. Hence, they apply fossil fuel distribution found in bond indices and equity indices (e.g. PIMCO Global Advantage Bond Index is used as a benchmark). Furthermore, to aggregate bank loan exposure they rely solely on syndicated bank loans, hence their calculations do not account for bilateral loan information. Weyzig et al. did not include insurance companies in full detail in this analysis and derived exposure estimates for the insurance sector from estimations from consulting companies.

³³ In order to estimate the exposure of the EU area institutional sectors to the fossil fuel and other climate-sensitive sectors, Battiston and Stolbova (2020) combine the macro-level data on the amount of bonds and loans held by institutional sectors from ECB DataWarehouse with micro-level data on bond and loan issuance gathered from Thomson Reuters and loans from Bureau Van Dijk Orbis database. For the estimations, they assume that EU financial institutions hold bonds and loans proportionally to the bonds and loans issued in the EU Area. They estimate that the combined exposure of banks, insurance and pension funds, and investment funds to the fossil-fuel sector is relatively small at about 1.5% of all assets for all Euro Area Institutions. Additionally, their calculations indicate that direct exposure to fossil fuels is concentrated within loans and bonds for banks, while equity exposures to fossil fuels are much higher within pension funds and investment funds.

³⁴ To quantify the exposures to transition risk, Alessi and Battiston (2021) develop the Transition-Exposure Coefficients (TECs), that vary from 0%, for sectors that do not need to transition, to 100%, for activities that will need to be abandoned going forward. Fossil fuel firms have TECs of 100% and considered sectors are fossil fuels, energy, manufacturing, buildings. The widespread and uncertain nature of climate related risks will lead to losses across a broad range of assets which can further amplify the economic shock due to the materialization of stranded fossil fuel assets.

of bank credit supply, coverage by insurance companies, or otherwise adversely affect the behavior of financial institutions. Assessments of climate change transition risk for the financial system using models that take into account bank interconnectedness and bank sector contagion find that in an early transition implying a gradual phase out of fossil fuels, the losses borne by the banking sector would be contained. Conversely, a disorderly, abrupt transition to a low carbon economy might have disruptive effects on the financial system due to larger and potentially systemic indirect exposure of financial actors via financial networks.³⁵

Sovereign exposures constitute a less discussed indirect fossil fuel exposure for banks that is also not represented in climate related disclosures. In countries that are highly dependent on fossil fuels, the cost of climate misalignment and the realization of stranded assets could affect sovereign creditworthiness, and the public finances of economies to which banks are exposed to, with potential implications for financial stability.³⁶ There is only little research on the impact of stranded assets risk on sovereign bonds or borrowers but some indication that climate change vulnerability has adverse effects on sovereign credit ratings and the sovereign cost of capital.³⁷

3.2.3. Fossil Fuel Exposure and Carbon Budget Scenarios

The magnitude of the stranding fossil fuels linked to banks' financial assets in the decades ahead remains a topic of debate given uncertainty over the pace of warming and consequent climate policies. There have been efforts to explore fossil fuel reserves that would become stranded and their geographical distribution under 1.5°C or 2°C pathways.³⁸ Most of this stranding assets literature aims to measure potential future stranding risk by comparing carbon balances to known reserves. Table 1 presents two often cited carbon budget estimations. McGlade (2015) estimate that to likely stay within a 2°C scenario 1/3 of oil, 50% of gas and 80% of coal reserves need to remain unburnable. The Carbon Tracker Initiative (2017) estimates that in order to achieve the 2°C scenario with an 80% probability, overall only up to 20 per cent of fossil fuel reserves can be extracted. Similarly, Welsby et al. (2021) assess the amount of fossil fuels that would need to be left in the ground, regionally and globally, to allow for a 50 per cent probability of limiting warming to 1.5°C. They find that nearly 60% of oil and fossil methane gas, and 90 per cent of coal must remain unextracted.

Different studies discuss stranding assets in terms of loss of asset value estimations in forgone revenue or profits of fossil fuel companies.³⁹ A variation in estimates is due to the sensitivity of the analysis to different assumptions with regards to fossil fuel price projections, time frames and baseline and climate stabilization projections. Overall, the estimations show that policies to address climate change will require that large quantities of oil, natural gas, and coal remain underground. The reserve devaluation will stem not only from fuels left in the ground but also to a large part from consequent price decreases for fuels that will still be extracted and sold during climate stabilization.

³⁵ The implications of climate change for financial stability are discussed in Financial Stability Board (2020) or Monasterolo (2020). Further literature provides insights into how banks' interconnections can contribute to the vulnerability of the banking system in the face of stranded assets (Alessi & Battiston, 2021; Battiston & Stolbova, 2020; Belloni et al., 2022; Roncoroni et al., 2019; Stolbova et al., 2018).

³⁶ McGlade and Ekins (2015) highlight that some countries would need to leave much higher proportions of fossil fuel reserves in the ground than others. Typically in countries that are highly dependent on fossil fuels, state-owned companies would be affected most in the case of oil and gas, as they own the majority of reserves (Ekwurzel et al., 2017). Globally, an estimated three-quarters of stranded assets belong to governments (Hansen, 2022).

³⁷ This effect seems to be less pronounced for advanced economies (Cevik & Jalles, 2020; Volz et al., 2020). The impact on sovereign bonds depends on the transition scenario but if an unexpected transition to a low-carbon economy occurs, it could have a significant impact on financial institutions' portfolios (Battiston et al., 2019).

³⁸ 1.5°C emission pathways are according to the PICC defined as those that, given current knowledge of the climate response, provide a one-in-two to two-in-three chance of warming either remaining below 1.5°C or returning to 1.5°C by around 2100 following an overshoot.

³⁹ Curtin et al. (2019) provide an overview.

Table 1. Estimations on global stranded fossil fuel assets

1.5°C in 2050	2°C in 2050
58% oil	33% oil
56% fossil methane gas	49% fossil methane gas
89% coal	80% coal
Source: Welsby, Price, Pye, & Ekins, (2021)	Source: McGlade and Ekin (2015)

Although there are efforts to focus the debate back to achieving a 1.5 °C scenario, given the current policies, pledges by governments and population growth forecasts many estimate that, despite large-scale efforts, CO₂ emissions from fossil fuels will unfortunately probably exceed the 1.5 °C carbon budget.⁴⁰ So the bigger risk of stranded assets for fossil fuel firms would come from the 1.5°C scenario. In fact, there should be no new oil and gas fields approved for development nor new coal mines or mine extensions beyond projects already committed as of 2021 in order to stay consistent with the 1.5°C scenario.⁴¹ In this context, future capital expenditures into fossil fuel constitute also part of the risk of stranded assets if fossil fuel firms and indirectly financial institutions do not refrain from overinvesting in the future fossil fuel, e.g. anticipating a 2°C or even laxer scenario instead of a 1.5°C scenario.

While these estimates provide some insight into how much of the direct fossil fuel exposure of financial institutions might be translated globally into stranded assets, the mapping of fossil fuel exposure to stranded assets risk is a complex task. A proxy metric for the risk of stranded assets based on underlying fossil fuel reserves needs to consider current and future public policies, potential technology changes, and customer sentiment. The realization of stranded assets is characterized by regional differences. First, unextractable fossil fuel shares vary substantially by region, relative to the global estimate. Second, fossil fuel support and consequently, policy stringency with regards to the extraction of fossil fuel reserves vary across countries as well. Therefore, banks risk derived from their fossil fuel exposure depends also on the geographical location of the underlying fossil fuel reserves.⁴²

3.3. Banks' Weighted Climate Policy Exposure

3.3.1. Climate Policy Exposure of Underlying Fossil Fuel Firms / Weighted Climate Policy Exposure

To approximate fossil fuel firms' risks associated with stranded assets, one has to consider the climate policy stringency in the location of firms' fossil fuel reserves. To proxy a fossil fuel firms stranded assets risk, we construct the firm-time variable "Climate Policy Exposure" by weighing the climate policy index of a country with the firms' relative amount of fossil fuel reserves in that country as demonstrated in

⁴⁰ The IPCC adopts 1.5°C as the target threshold in their special report published in 2018. The comparison between global warming of 1.5°C and 2°C above pre-industrial levels shows that limiting global warming to 1.5°C would reduce challenging impacts on ecosystems, human health and well-being, making it easier to achieve the United Nations Sustainable Development Goals," (IPCC, 2018; World Economic Forum (WEF), 2018)

⁴¹ See for reports by the International Energy Agency (2021) and Global Witness (2019).

⁴² Appendix D elaborates on the geographical distribution extractable fossil fuel reserves and of syndicated bank loans granted by European banks.

Equation 1. The relative reserves of firms, we hand-collect from firms balance sheets and to measure a country's climate policy stringency we use mainly the Climate Change Policy Index (CCPI) by Germanwatch which is available for the period 2007-2017 for 58 countries.⁴³ Large energy companies are going to have reserves in different countries, and these reserves are going to be exposed to differential climate policy stringency, which is what we capture. A higher climate policy exposure "CPE" indicates a higher average level of fossil fuel reserves in countries with stricter climate policy.

Fossil fuel firms' Climate Policy Exposure (CPE):

$$CPE_{t,i} = \sum_c Relative\ Reserves_{t,i,c} \times CCPI_{t,c} \quad 1)$$

Optimally, banks should provide key metrics used to measure stranded assets risk that are comparable within their sectors. TCFD aims to establish relevant metrics to common carbon footprinting and exposure metrics, however does not require a common standard for the risk of stranded assets for banks yet. We propose to derive the Weighted Climate Policy Exposure (WCPE) of financial institutions from the Climate Policy Exposure of the underlying fossil fuel firm to which they provide financing. To construct this variable we first group syndicated bank loan observations issued to fossil fuel firms with CPE>0 by issuance year and the parent company of the lender, and then we sum, by lender parent and year, the product of the CPE of a fossil fuel firm and the relative loan amount. The coverage can include all loans issued in a year to a fossil fuel firm for which we were able to calculate CPE beforehand, consequently we are only able to do this exercise if there is sufficient variation in terms of fossil fuel financing by a parent bank. The analysis of the WCPE in Figure 3 exemplary covers 7 of the biggest - by asset size - and most relevant - in terms of fossil fuel financing volume - banks in the Europe for which there is sufficient variation in loan observations. While we calculate the WCPE to assess the exposure of newly issued debt, looking at banks WCPE based on outstanding fossil fuel exposure would be informative as well. Characteristics of this metrics are that it allows us to compare stranded assets risk intensity of loan portfolios of different banks across time, which would allow for trend analysis. More generally, the WCPE or similarly constructed metrics could be applied easily across asset classes.

We find that the metric for all banks have been increasing through time. This likely implies that climate policy gradually is becoming more stringent where the underlying fossil fuel reserves are located. Downward shift of the WCPE may hint that banks undertake action to move towards less risky fossil fuel firms in terms of CPE. Figure 4 shows the annual average fossil fuel share of the total commitment size of Dealscan facilities provided by the 7 banks in Figure 3 for which the annual WCPE has been calculated. While banks have on average over the years not been decreasing the stranded assets riskiness of their syndicated bank loan portfolios, Figure 4 shows that their exposure to fossil fuel firms in terms of loan volume relative to their total syndicated bank loan portfolio has not been decreasing either.⁴⁴

⁴³ This measure is used in Delis et al. (2021) and Beyene et al. (2021). To measure climate policy risk the Climate Change Performance Index (CCPI) by Germanwatch is mainly used. This index is available in a consistent manner for the period 2007-2017 for 58 countries and compares countries based on different components such as policy and emission levels (Burck et al., 2018). The data for 2018-today is not comparable with the data for 2007-2017 as the methodology was changed in between those editions.

⁴⁴ An assessment that is consistent with a more comprehensive analysis of these banks' credit portfolio in Rainforest Action Network (2021).

Banks syndicated bank loans Weighted Climate Policy Exposure (WCPE):

2)

$$WCPE_{b,t} = \sum_i \frac{\text{Loan Exposure}_{b,i,t}}{\text{Total Exposure}_{b,t}} \times CPE_{t,i}$$

Figure 3. European banks weighted climate policy exposure

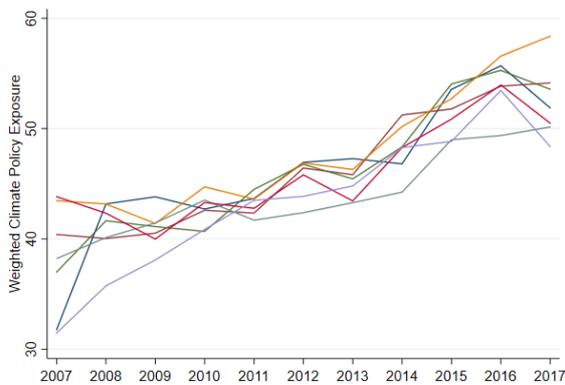
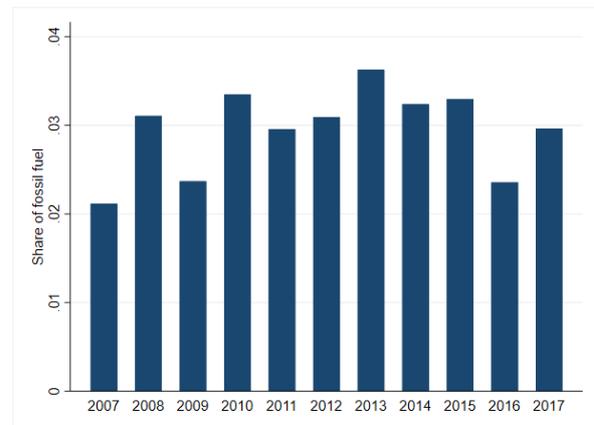


Figure 4. Share of fossil fuel firms in European banks' syndicated bank loans



Source: Own illustration based on Dealscan syndicated bank loan data.

3.4. Pricing of Stranded Assets Risk

An orderly low-carbon transition through financial systems would require that financial markets efficiently allocate capital, assess and transfer risks, and facilitate price discovery. A failure to price in the risk of stranding assets in fossil fuel and other carbon-related loans and investments can lead to costly consequences for the whole economy. First, the resulting misallocation of capital due to delayed divestment could render the transition to clean capital more expensive.⁴⁵ Second, a late and unexpected tightening of carbon emission policies or sudden changes in expectations can lead to abrupt repricing of fossil fuel assets. The greater the continued fossil fuel investments is due to the lack of appropriate pricing in the meantime, the larger the negative supply shock through changes in energy use and second-round effects in financial markets will be. Appropriate pricing of fossil fuel and other carbon-related loans and investments would make banks less vulnerable to the risks of declining prices and increasing loan defaults.

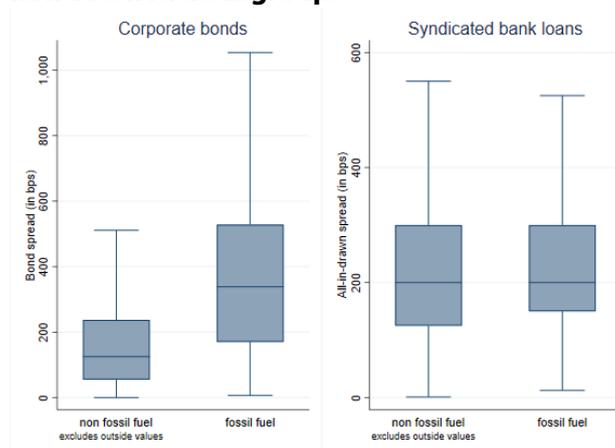
Banks appear to have been slower at pricing climate risks than other financial market participants. Using the climate policy exposure variable (see equation 1 in chapter 3.3.1), Delis et al. (2021) find salient evidence banks on average started pricing the stranded asset risks in syndicated bank loans only post 2015.⁴⁶ Beyene et al. (2021), using the CPE variable for fossil fuel firms, compare the corporate bond spreads with the syndicated bank loan spreads charged to fossil fuel firms along the risk of their assets stranding. The sample is limited to companies with access to both syndicated bank credit and the corporate bond market, so they are by definition less financially constrained. Figure 5 shows the

⁴⁵ For example reports by the International Energy Agency (IEA) (2021), the IPCC (2018) and Batten et al. (2016) highlight the cost of a late transition due to delayed investments investment in a late transition that highlight.

⁴⁶ Additionally, Reghezza et al. (2021) showed that following the ratification of the Paris Agreement, banks reallocated credit away from polluting firms- whereby they define polluting firms as those firms which have an above-median level of CO2 emissions, where the median level is 2,093,000 tonnes of CO2 per year. Firms rebalancing of portfolios away from high polluting firms to achieve does not imply anything for fossil fuel investment.

median corporate bond spread and syndicated bank loan all in drawn spread for fossil fuel and non-fossil fuel firms; newly issued corporate bonds in the fossil fuel industry appear to have higher relative yields to non-fossil fuel sectors than what is the case in the syndicated bank loan market. The empirical results in Beyene et al (2021) evidently suggest that as climate policy exposure increases, bond markets require a higher premium relative to the implicit credit spread of syndicated bank loans. Fossil fuel company bonds are issued at a higher yield than their non-fossil fuel counterparties. The same is not observed for fossil fuel companies' syndicated bank loans.⁴⁷

Figure 5. Box plot of spreads for the fossil fuel and non-fossil fuel subgroups



Source: Own illustration based on Dealscan syndicated bank loan data and Thomson Reuters corporate bond data.

If price-formation does not reflect stranded asset risk, this may lead to misallocation of capital and supervisory interventions seeking to correct this lack of risk-adjustment may be justified. The idea of incorporating climate-related risks into banks' capital requirements is emerging as higher risk weights on banks' fossil fuel exposures may dampen systemic risk that arises when risk is priced too low. Risk-weighted assets, or RWA, are used to link the minimum amount of capital that banks must have, with the risk profile of the bank's lending activities (and other assets). The more risk a bank is taking, the more capital is needed to protect depositors. Risk weights are essentially percentage factors that adjust for the credit risk of different types of assets. Within the EU one could rely on the Capital Requirements Regulation (CRR) to incorporate fossil fuel exposure in banks risk-weighting schemes. Article 128(3) CRR provides a mandate to the European Banking Authority (EBA) to draft guidelines that specify which types of exposures, other than those mentioned in Article 128(2) CRR, are to be associated with particularly high risk and the circumstances under which this should happen. As a result of an exposure being identified as an item of particularly high risk', such exposure receives a risk weight of 150%.⁴⁸

⁴⁷ To illustrate the magnitude of the effect we can compare the cost of debt for a firm that has all its fossil fuel reserves in Australia to a firm that has all its reserves in the United Kingdom. The UK has strict climate policies where Australia is laxer which translates into an approximately 30 Index point difference in the CCPI. Bondholders charge 48 extra basis points for this 30 index point increases from Australia to the United Kingdom (Beyene et al., 2021).

⁴⁸ This high-risk exposure class represents the implementation of the discretion that national supervisors are granted in paragraph 80 of the current Basel II standard that states that national supervisors may decide to apply a 150% (or higher) risk weight to reflect "the higher risks associated with some other assets, such as venture capital and private equity investments."

3.5. Possible Measures Mitigating Fossil fuel Exposure of Banks

For banks to make prudent fossil fuel investments decisions, it is urgent to establish an asset stranding policy, preferably a gradual approach to minimize risks. Box 1 highlights possible measures counteracting fossil fuel exposure of financial institutions. Strategies to deal with stranded fossil fuel assets in financial institutions' balance sheets include the adoption of long-term predictable climate and energy policies that disincentivise the provision of credit to fossil fuel firms. Recognising the risk of stranded assets may also result in divestment strategies from fossil fuel assets by financial institutions, enforcing transparency and disclosure for stranded asset risks on balance sheets and portfolios could have this effect. Lastly, the systemic risk derived from banks' fossil fuel exposure can be addressed with macroprudential-like tools such as systemic risk buffers.

Box 1 Possible measures against fossil fuel exposure of banks

- (i) **Climate Policy:** Ensure a stable and integrated policy environment including the adaptation of clear and effective long-term climate and energy policies that set the right incentives for fossil fuel divestment.
 - Fossil fuel subsidy cuts and carbon price to account for negative externalities of fossil fuel financing
 - Fossil fuel exploration moratorium
- (ii) **Climate Disclosure:** Ensure a robust and transparent reporting of exposures to fossil fuels in a timely manner to strengthen market discipline and provide supervisors with better and more consistent information
 - Stranded asset risk and decarbonisation strategies related disclosures to promote market transparency and discipline as well as improve data collection.
 - Common approach for the calculation of "fossil" exposures and decarbonisation strategies to ensure comparability across institutions.
- (iii) **Regulation and Supervision:** Ensure a prudential response to fossil fuel related-risks.
 - Governance and risk management requirements. Formulate supervisory expectations and requirements with respect to climate and environmental risk management
 - Supervisory climate stress testing
 - Incorporating climate-related risks into banks' capital requirements
 - Incorporate climate criteria into monetary policy frameworks. Adapt collateral frameworks and loan schemes to adequately reflect climate risk and give preference to green assets
 - Macroprudential(-like) instruments. Sectoral (or targeted) systemic risk capital buffer applicable to all fossil fuel exposures; maybe to be increased in level over time as to increasingly put pressure to phase out bank fossil fuel firm lending

4. FOSSIL FUEL EXPOSURE TRENDS AND DEVELOPMENTS

4.1. Big Banks Continued Fossil Fuel Investments and other Potential Patterns in Fossil Fuel Credit Flow

Recent research allows insights into potentially changing patterns of bank capital flows and their implications as a result of climate transition. These changes reoriented rather than reduced concerns about the potentially adverse impacts of continuing fossil fuel investments. Table 2 recaps research highlighting potential reasons underlying continued fossil fuel investments by banks as well as research on diverted capital flows in the context of climate policy emergence.

Table 2. Potential patterns in bank fossil fuel credit flows

Inter-temporal	Delayed oil and gas divestment.	e.g. Clark (2022); Rainforest Action Network (2021)
Within-fossil fuel sector	Coal divestments offset by oil and gas investments.	
Cross-border	Increased cross-border lending in response to higher climate policy stringency in home countries.	Benincasa et al. (2021); Laeven & Popov (2021)
Bond-to-bank	Big banks “lead manage” fossil fuel firms with reserves exposed to climate policy stringency from bond market to bank financing.	Beyene et al. (2021)
Small-to-large bank	Stranded asset risks are concentrated in a few large exposures for some large banks.	Beyene et al. (2021); Rainforest Action Network (2021)

Even though more and more financial institutions state that net-zero is a necessary goal and are directing funds towards green purposes, they are far from phasing out from fossil fuel investments. A big driver of continued fossil fuel investments is that fossil fuel firms have remained significantly more profitable than renewable energy firms.⁴⁹ Arguably, it may be disadvantageous for banks to be a first-mover in the absence of meaningful carbon pricing or other government policies that would lead to a sharp and permanent decline of fossil fuel prices. The question whether banks create appropriate economic incentives to facilitate the transition to a greener economy further boils down to whether some banks, particularly the largest ones, are more shielded from transition risks. Beyene et al. (2021) hypothesize potential reasons why banks may be more willing to finance fossil fuel firms linked to reserves that may become stranded. Some of the important advantages of large and systemically important banks include their ability to diversify risk and the higher capital requirements they face; both making them less vulnerable to high-carbon counterparties in their loan portfolios and consequent stranded assets risks related losses. Another component to this is the political economy

⁴⁹ See for example Hansen (2022).

argument that some banks are politically connected and responsive to national needs and therefore more in control of politically determined transition risks.⁵⁰ Lastly, very large banks are considered too-big-to-fail (TBTF), implying that these banks may expect to be shielded from the negative consequences of transition risks; and therefore have a greater incentive to take on transition risks compared to bondholders or smaller banks. This potentially could lead to a too-big-to-stand type of situation where the price of bank loans issued by TBTF banks will not fully reflect their risk.⁵¹

For the above reasons, large banks may be encouraged to provide ongoing loans to the fossil fuel sector and thus accumulate the risk of stranded assets in their balance sheets while others de-risk. According to the European Systemic Risk Board (2022), exposures of euro area banks to high-emitting firms appear limited on average, but “*are concentrated in a few large exposures for some banks*”. In general, banks appear to have been slower at pricing climate risks than institutional investors in debt, resulting in a banks potentially taking on stranded assets risks that the market would not. Beyene et al. (2021) establish in a second component of their analysis that, with increasing exposure to fossil fuel assets with a high likelihood of stranding, measured by the Climate Policy Exposure, fossil fuel firms increasingly substitute bonds for syndicated bank loans. In addition to this transition of bond to banks, they also observe within the banking sectors itself some heterogeneity and some tentative evidence of a migration along bank size.

Banks may also be able to take on the role of default fossil fuel financiers because they face less scrutiny from stakeholders. Cojoianu et al. (2021) show that the fossil fuel divestment movement has been to some extent successful in reducing new capital flows into the fossil fuel sector, but domestic banks situated in countries with high divestment commitments and stringent environmental policies provide more finance to oil and gas companies abroad. Investor demands are driving asset managers' ESG focus. This is illustrated by high-profile fossil fuel divestments made in recent years by investors ranging from Nordic sovereign wealth funds to US pension funds. On the other hand, anecdotal evidence shows that private investors and state-owned fossil fuel corporations that face less public and regulatory scrutiny are stepping in as others move away from the fossil fuel financing business. Private equity firms are estimated to have invested more than \$1 trillion in the energy industry since 2010, mostly in fossil fuels, which underlines where the net zero financing “battle” may be heading also.⁵² Because bank lenders provide the leverage for fossil fuels buyout deals this trend may transfer yet again into increased indirect fossil fuel exposure.

If banks will face in the near future much more stakeholder scrutiny on carbon exposure in their loan portfolios – especially if no plans exist to align with a fossil fuel exit, there is an increased risk that banks will shift their fossil fuel financing towards opaque instruments and off-balance sheet affiliated entities that would step in and take over risky fossil fuel finance from big banks to some extent. Fossil fuel related bank policies and disclosure commitments exclude off-balance sheet activities like underwriting - this allows banks to not address fossil fuel underwriting exposure although it makes out a substantial portion of their fossil fuel financing.⁵³ The opaque governance and ownership structures between banks and so-called shadow banks would imply that fossil fuel asset are shifted into an

⁵⁰ For example, Chen et al. (2018) examine the effect of political connection on banks' performance during financial crises. Bertrand et al. (2021) show how banks may increase their influence over the political process via corporate ownership.

⁵¹ See for example Grossman and Wolf (2014) on the political economy of bailouts.

⁵² See Giachino & Mehta-Neugebauer (2021) and Tabuchi (2021)

⁵³ The Rain Action Network (2021) notes that over 50% of the top banks' financing for fossil fuels comes from share issuance and bond underwriting and that it is therefore banks' climate policies and disclosures covered underwriting as well as lending.

opaque environment, that is characterized by a lack of disclosure and information about the value of the assets and little regulatory or supervisory.⁵⁴

On the one hand, European banks indicate to apply more exclusion strategies to coal compared to oil and gas firms in the near future and some European banks have already reduced backing for coal over time.⁵⁵ On the other hand, as there is less of a future for coal-fired electricity generation fuel, financing gas as a “bridge fuel” would allow banks to ramp up fossil fuel investments while appearing greener. Therefore, if fossil fuel financing is to stop policy must be consistent across the entire industry.

Banks freely choose the jurisdiction where to locate their activities and have private information about their efficiency level. Laeven and Popov (2021) show that banks respond to the introduction of domestic carbon taxes by increasing finance of coal, oil, and gas firms across national borders. Confirming this finding with a more general approach, Benincasa et al. (2021) show that banks use cross-border lending as a regulatory arbitrage tool by increasing their lending to firms located in countries with laxer climate policies.

These potential trends inform climate policy inasmuch as that in the end, all papers agree that only a well-coordinated approach by national governments can ensure the proper financing of the transition. If fossil fuel financing by all financial institutions is to stop and not just to be transferred to other sources and/or other countries, a well-coordinated approach by national governments and policy that is consistent across the entire industry is required.

5. FOSSIL FUEL EXPOSURE IN THE SHORT-TERM AND LONG-RUN

The time horizons over which transition-related effects are projected to materialize strongly depend on the timing and stringency of climate policy. While some advocate a gradual transition, others emphasize the importance of redirecting investments rapidly in order to meet the Paris Agreement targets. A gradual transition to a low carbon economy scenario would require an adaptation of unified clear and effective long-term climate and energy policies.⁵⁶ In the case of a gradual transition, optimistically, stranded asset risk could be priced in gradually over time. However, today, a gradual scenario would imply that the goals of the Paris Agreement will not be reached.⁵⁷ Scenarios that seek to achieve the goals of the Paris Agreement of 1.5°C imply immediate and ubiquitous measures and are therefore seen as rapid and disruptive to the fossil fuel sectors. As a credible and effective implementation of climate policy will imply rapid declines of fossil fuels because markets will begin to recognize that the values of the reserves on fossil fuel books are untenable, and the value of the fossil fuel firms will fall considerably as a consequence of these stranded assets and lower energy prices. Thereafter, fossil fuel exposure on financial institutions balance sheets will start to transform to losses.

Often referred to is the IEA Sustainable Development Scenario (SDS) that describes an integrated pathway for the global energy sector to meet the Paris Agreement goals. Hansen (2020) estimates that once climate stabilisation scenarios in accordance with the SDS scenario begin, fossil fuel firms will have little to no time before suffering economic losses in terms of both income and wealth which

⁵⁴ See also on shadow-banking incentives e.g. Kroszner & Strahan (2011) and Buchak, Matvos, Piskorski, & Seru (2018).

⁵⁵ Electricity produced from coal has the highest climate impact of all types of fossil fuels. The last few years have seen some progress in phasing out direct financing for coal mining and coal-fired power plants by some Euro Area banks. See for example a best practice analysis of coal financing policies by Rainforest Action Network (2021). However, a lot of support still flows into the coal sector (Chan et al., 2022).

⁵⁶ Many unknown factors come into to play, for example the potential impact of carbon capture and removal technologies, etc. (International Energy Agency (IEA), 2021).

⁵⁷ See for example the IPCC's (2021) Sixth Assessment Report (AR6) of Working Group I from 2021.

naturally translates into credit risk for financial institutions. He estimates that nearly half of income losses for fossil fuel firms because fossil fuel reserves create less profits occur from 2020 to 2030, with 15%–16% occurring from 2020 to 2025.⁵⁸ Thus, the fossil fuel industry will be significantly less profitable in the short-term in a climate stabilisation scenario.

The short-term profit losses are due mainly to the price effect. An increase in carbon prices as a result of a carbon tax or other measures could wipe out a large share in fossil fuel revenues. Fossil fuel firms warn that low energy prices, in fact such actually required to meet the carbon budget, could remove a large portion of fossil fuel reserves from their books.⁵⁹

In any case, a "too-late-too-sudden" transition is recognized to likely cause the largest losses for financial institutions and also imply a greater risk of financial stability. A sudden, unexpected tightening of carbon emission policies would not only lead to an economic shock due to large swings in asset prices but the situation would be amplified by second-round effects in financial markets.⁶⁰ First, delayed risk-adjustments in balance sheets and portfolios for stranded asset would evidently lead to higher exposures and the resulting costs of the climate stabilization will be correspondingly higher. Second, the initial shock of this revaluation could trigger systemically relevant second-round effects. Battiston and Stolbova (2021) highlight the fact that interconnectedness of the interbank market could amplify distress caused by climate stabilization, an effect only multiplied in a "too-late-too-sudden" scenario with potential implications on systemic risk. To conclude, the likelihood of the fossil fuel industry to ignite a financial crisis is largest in the case of a disorderly and late transition. Delayed climate policy is not only costly but may also lead to increased fossil fuel production in the meantime. This risk of stranded assets in the context of a late and sudden transition would be further exacerbated by increased fossil fuel extraction and future capital investment into fossil fuel until the transition. If stranded assets mostly occur only later, the fossil fuel industry can expect to continue accumulating high profits for more than a decade. Additionally, holding periods for banks' financial assets would be short compared to the time horizons over which transition-related effects are projected to crystallize in a too-late scenario these profits would translate for banks as well.

⁵⁸ Stranded reserves stems from the expectation that fossil fuel production will create substantially lower profits in a climate stabilization scenario

⁵⁹ The loss of income is not only due to stranded reserves, hence that lower volumes of fossil fuels can be sold but also due to the fact that fossil fuels can only be sold at lower prices in a 2°C scenario compared to in a hypothetical business-as-usual scenario. See e.g. Riedl (2021)

⁶⁰ As discussed in Drudi, et al., 2021; Stolbova, Monasterolo, & Battiston, 2018.

6. CONCLUSION

- In the **absence of material quantitative information on banks' exposure towards fossil fuel assets in their portfolios and balance sheets**, it is difficult to assess banks' risk derived from stranded assets as well as consequent macro-prudential risks.
- **Despite more voluntary disclosure commitments aligned with TCFD and recently imposed government requirements for reporting on climate change risks**, banks do not yet meet expectations on disclosure that would foster market discipline and help supervisory and regulatory authorities to monitor, manage and mitigate stranded asset risks. There is first evidence that voluntary commitments and explain-or-comply approaches may not be enough to stop climate cheap talk.
- **Net-zero commitments as well as current disclosure initiatives do not dictate or specify what needs to happen in the fossil-fuel sector and are inclined more towards target-setting, and corporate engagement.** Reporting on decarbonisation pathways by financial institutions would be a simple, transparent tool to examine institutional investors' future exposure to carbon transition risk and, if necessary, to require adjustments in portfolios with incompatible net-zero trajectories.
- **An emerging string of literature examines the interaction between climate transition and bank lending.** Recent findings include that credit constraints may inhibit corporate investment in green technologies as well as reduce toxic emissions and fossil fuel procurement may face less external financial frictions than investments in green technology. And, financial markets and banks can differ in the way they reallocate credit across and within different climate-relevant industries.
- **To proxy fossil fuel firms' stranded assets risk, based on previous work, we construct a variable Climate Policy Exposure as the product of a country's climate policy stringency and the relative amount of reserves a firm has in this country. Based on fossil fuel firms Climate Policy Exposure, we derive the Weighted Climate Policy Exposure (WCPE) of banks' syndicated bank loan portfolios.** Looking at the WCPE of 7 of the largest European banks based on their syndicated bank loan exposure. We find that the metric for all banks have been increasing through time.
- **Simultaneously, the exposure to fossil fuel firms has not been decreasing.** After the Paris agreement in 2015, reports show that the largest banks have continued to finance fossil fuel firms, implying fossil fuel financing levels higher in 2020 than in 2016.
- **Direct exposure of financial assets to the fossil-fuel sector is relatively contained in monetary terms across bank debt holdings.**
- **Financial interlinkages of institutional sectors within financial networks could result in significant indirect exposure to climate policy shocks.** Various financials contracts such as loans, bonds, equity, insurance, pension schemes would determine how in the case of a sudden re-evaluation of fossil fuel assets a corresponding shock would propagate through the financial system and potentially come back to an actor amplified.
- **Today, scenarios that seek to achieve the goals of the Paris Agreement, limiting global warming well below or 2°C, are seen as disruptive to the fossil fuel sector.** As a credible and effective implementation of climate policy will imply rapid declines of fossil fuels because markets will begin to recognize that the values of the reserves on fossil fuel books are untenable, and the value of the fossil fuel firms will fall considerably as a consequence of these stranded assets.
- **Once climate stabilization scenarios begin, fossil fuel firms will have little to no time before suffering economic losses due to the price effect.** Thereafter, fossil fuel exposure on banks' balance sheets will start to transform to losses.
- **A "too-late-too-sudden" transition is recognized to cause the largest losses for financial institutions and also imply a greater risk of financial stability:** 1) delayed risk-adjustments in balance sheets and portfolios for stranded assets would evidently lead to higher direct and indirect

exposures and the resulting costs of the climate stabilization will be correspondingly higher; 2) the initial shock of this revaluation could trigger systemically relevant second-round effects.

- **Banks may be willing to replace lost capital market funding in the context of increased climate policy risk.** Complementary research indicates that **banks increase their cross-border lending in response to a greater climate policy stringency** in their home country, if the home country has a more stringent climate policy than the borrowers' countries. **Policy makers therefore have to reflect on how to best limit regulatory arbitrage.**

- The **range of possible approaches to mitigate financial institutions' continued fossil fuel exposure** could include (i) disclosures on stranded assets risk and decarbonisation strategies (ii) fossil fuel subsidy cuts, carbon prices and fossil fuel extraction moratoriums (iii) governance and risk management requirements, supervisory climate stress testing and incorporation of climate-related risks into banks' capital requirements as well as monetary policy frameworks, and lastly macroprudential(-like) instruments

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ANNEX

Appendix A Information from Financial Databases

We establish that there is a lack of disclosure of detailed information on portfolios of banks and fossil fuel companies. This makes it difficult to fully assess fossil fuel exposure from fossil fuel firms, through financial institutions, to the financial system. Nevertheless, the combination of data on bonds and loans issuance can shed light on the estimation of climate related exposures in debt holdings of financial institutions. This data on debt issued by fossil fuel companies can be retrieved from a handful of financial databases.

Banks undertake a range of services and functions. With regards to fossil fuel exposure, we present figures for syndicated bank loans. Syndicated bank loans make a significant portion of banks' total loan portfolio. Fossil fuel firms are debt-intensive and source large amounts of funds. For this reason, syndicated bank loans may be the preferred debt instrument as opposed to bilateral bank loans. By forming syndicates, banks can diversify while avoiding taking the full size of the loans on their balance sheets.⁶¹ Syndicated bank loans issued by fossil fuel firms can be tracked via DealScan from Refinitiv Loan Connector. Other than banks, various types of institutional investors partake in syndicated bank loans despite having different costs and hence return expectations of providing debt capital. In contrast to traditional single-lender loans, syndicated loans are jointly extended by a group of lenders and are structured, arranged, and administered by one or several lead arrangers that negotiate the key terms of the loans.

To collect individual bilateral bank to firm credit exposures one needs access to the European Central Bank's AnaCredit and/or to national credit registers. Data from Bureau Van Dijk Orbis provides also firm-level data on received loans, however without information on the lender counterpart. A look at the sectoral distribution of corporate bond markets reveals that a significant portion of debt funding for fossil fuel firms likely comes from corporate bonds. Micro-level data on the issuance of bonds by a company can be retrieved for example from Thomson Reuters or Bloomberg - devoid of information on lender /security holder counterpart.

Macro-level data on the amount of bonds and loans held by institutional sectors can be retrieved from ECB Data Warehouse or Dealogic for the EU Area. Fossil fuel holdings of institutional sectors (e.g. banks insurance companies, etc.) can be derived from these datasets by making assumptions regarding the share of fossil fuel securities e.g. based on the fossil fuel issues in an area. The Securities Holdings Statistics (SHS) database provides a direct breakdown by not only institutional type but also sector of issuer. The SHS collected on a security-by-security basis, provide information on securities held by selected categories of euro area investors, broken down by instrument type, issuer country and further classifications.

⁶¹ See the use of syndicated bank loans in the context of climate change risks: (Cojoianu et al., 2021; Weyzig et al., 2014)

Appendix B Overview of Banks’ Fossil Fuel Disclosure Requirements

In recent years, regulatory efforts have been emerging that encourage or even mandate climate-risk disclosures. The TCFD framework has seen significant momentum by governments and regulators that have implemented it into policy and guidance and move toward requiring TCFD-aligned disclosures through legislation and regulation. For example, the UK is to enforce mandatory TCFD reporting from April 2022 on for large companies. Other jurisdictions that have already undertaken steps as well towards government-mandated disclosure for banks are New Zealand, and Switzerland (Mésonnier & Nguyen, 2021; Financial Stability Board, 2021).⁶² Further, central banks and monetary authorities have been intensifying quantitative work aimed at capturing climate-related risks to financial stability (Basel Committee on Banking Supervision, 2021). Where the required disclosures are aligned with the TCFD recommendations, it remains the onus of the banks to decide the extent of fossil fuel exposure they want to disclose.

The following table provides an overview of mandatory TCFD-aligned fossil fuel disclosure requirements that affect banks:

Country	Regulation	Earliest publishing date	Type	Disclosure on fossil fuel
UK	UK FCA Rules on Climate-Related Disclosures	2023	Comply-or-explain for UK-registered large private companies incl. banks	Scope of TCFD ⁶³
New Zealand	Financial Sector (Climate-related Disclosures and Other Matters) Amendment Act 2021 (FSAA)	2024	Comply-or-explain for registered banks	External Reporting Board (XRB) standard developed in line with TCFD ⁶⁴
Switzerland	Binding TCFD implementation for large companies by the Swiss Federal Council	2024	Mandatory for large companies incl. banks	Within the scope of TCFD

⁶² There are other legislative developments in various regions around the world. Some companies listed at stock exchanges in Japan, Hong Kong and Singapore will have to publish climate disclosure rules aligned with TCFD (Task_Force_on_Climate-related_Financial_Disclosures, 2021).

⁶³ Banks regulated by the Prudential Regulation Authority (PRA) are already subject to the supervisory expectations to have “fully embedded their approaches to managing climate-related financial risks”. With regards to disclosure the PRA set an expectation that firms should consider engaging with the Taskforce on Climate-related Financial Disclosures (TCFD) framework (Prudential Regulation Authority, 2019). The Financial Conduct Authority (FCA) implemented a TCFD-aligned disclosure requirement on a comply-or-explain basis for UK-registered companies in 2022 by which UK-listed banks are also affected. The disclosure requirement came into effect earlier for premium companies. Financial Conduct Authority (FCA)-regulated asset managers and asset owners - including life insurers and pension providers – are obliged to disclose climate related information on entity and product level (Financial Conduct Authority (FCA), 2021).

⁶⁴ The XRB is consulting on climate standards as part of a climate-related disclosures framework, and guidance on environmental, social and governance (ESG) matters. Once the XRB issues its first climate standard, banks will be required to comply or explain with the disclosure reporting requirements.

				recommendations ⁶⁵
EU	ITS on Pillar 3 disclosures on ESG risks	2024 ⁶⁶	Mandatory for largest listed EU banks	More detailed reporting requirements than TCFD recommendations
Brazil	Central Bank of Brazil TCFD-aligned disclosure rules for regulated institutions	2022	Mandatory for regulated banks	Within the scope of TCFD recommendations / only for qualitative aspects (a second phase should incorporate quantitative aspects)

⁶⁵ The Swiss Financial Market Supervisory Authority (FINMA) Authority amended disclosure rules for banks and insurers and is already requiring large banks and insurance companies to provide qualitative and quantitative climate risk information aligned with TCFD since the 2021 financial year annual report.

⁶⁶ Phase-in period until mid-2024 (European Banking Authority (EBA), 2022).

Appendix C Fossil Fuel Definition

For the most part in this paper, we classify a firm to be in fossil fuel sector if it has a Standard Industrial Classification (SIC) between 1200-1400.

1200 COAL MINING

1220 BITUMINOUS COAL, LIGNITE MNG

1221 BITMNS COAL,LIGNITE SURF MNG

1222 BITMNS COAL UNDERGRND MINING

1230 ANTHRACITE MINING

1231 ANTHRACITE MINING

1240 COAL MINING SERVICES

1241 COAL MINING SERVICES

1300 OIL AND GAS EXTRACTION

1310 CRUDE PETROLEUM & NATURAL GS

1311 CRUDE PETROLEUM & NATURAL GS

1320 NATURAL GAS LIQUIDS

1321 NATURAL GAS LIQUIDS

1380 OIL AND GAS FIELD SERVICES

1381 DRILLING OIL AND GAS WELLS

1382 OIL AND GAS FIELD EXPL SVCS

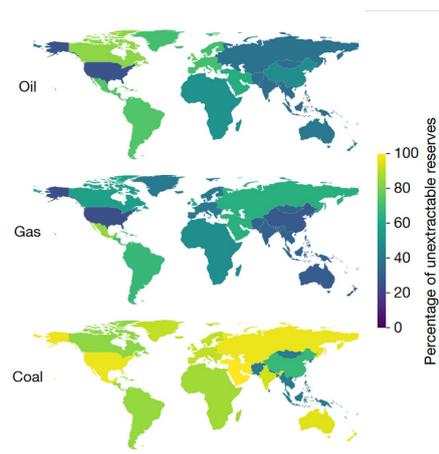
1389 OIL & GAS FIELD SERVICES, NEC

1400 MNG, QUARRY NONMTL MINERALS

Appendix D Fossil Fuel Exposure and Geographical Location

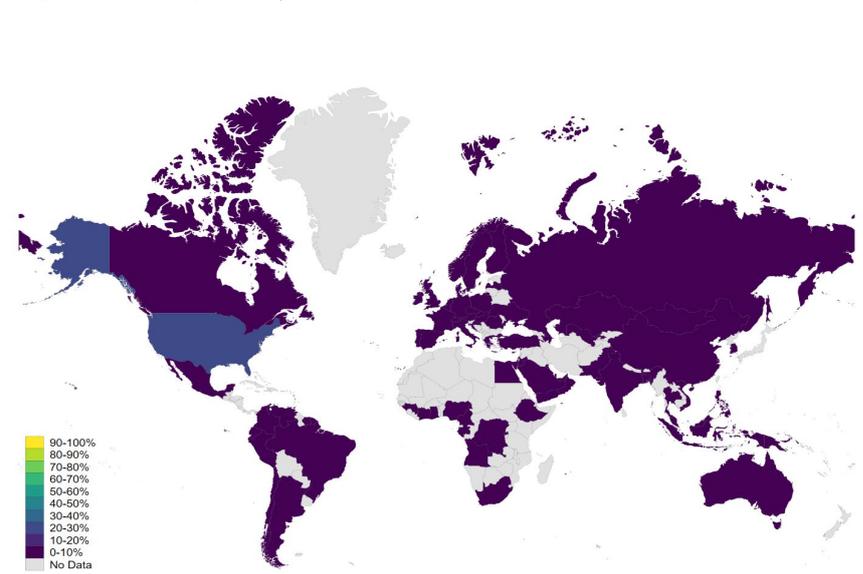
Welsby et al. (2021) in Figure A map the percentage of extractable reserves of oil, fossil methane gas and coal (from top to bottom) disaggregated into regions. Figure B illustrates the volume of syndicated bank loans provided by European lenders to fossil fuel borrowers from different countries and shares the same color coding from 0 to 100 percent as Figure A. A large part of syndicated bank loans provided by European financial institutions go to American fossil fuel firms. Out of the top twenty major carbon firms that have contributed to 35% of all energy-related carbon dioxide and methane worldwide from 1965 to 2017, only 8 are investor-owned as opposed to state-owned, out of which again, 4 are American multinational firms Taylor & Watts (2019). These large energy companies are going to have reserves in different countries, and these reserves are going to be exposed to differential climate policy stringency.

Figure A. Unextractable fossil fuel reserves by 2050 under 1.5°C scenario



Source: Figure from Welsby et al (2021); maps of the percentage of unextractable reserves of oil, fossil methane gas and coal (from top to bottom) disaggregated into the model regions.

Figure B. European syndicated bank loans to fossil fuel firms



Source: Own calculation based on Dealscan data; map of the percentage distribution of syndicated bank loan financing to the fossil fuel sector (SIC 1200-1400). The loan volumes issued by European lenders in the period from 2007-2017 are aggregated for each borrower country in order to calculate the percentage shares. The color coding is the same as that of Figure 3. For example USA is blue because 26 % of loans to the fossil fuel sector have gone there from 2007 to 2017.

Many financial institutions have warned that the transition to a low-carbon economy could cause a major shock to fossil fuel valuation, with the potential for systemic risk. This paper discusses disclosure commitments and empirical evidence in order to gauge the exposure of banks towards fossil fuel assets as well as the consequent implications for banks' balance sheets and for financial stability.

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