Too-big-to-strand? Bond versus bank financing in the transition to a low-carbon economy

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Abstract

What is the role market- and bank-based debt plays in the climate transition process? We present evidence that bond markets price the risk that reserves held by fossil fuel firms strand, while banks in the syndicated loan market do not. Consequently, fossil fuel firms increasingly rely less on bonds and more on loans. We interpret the within-firm bond-to-loan substitution in stranding risk as a contraction in the supply of bond credit versus bank credit. Within the banking sector, big banks provide cheaper and more financing to fossil fuel firms, possibly giving rise to a novel "too-big-to-strand" concern for banking regulators.

Key words: Climate policy risk; Financial intermediation; Stranded assets; Credit allocation; Bond to loan substitution

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1 Introduction

Transforming the present global economy into one that is sustainable over the long-term, given the physical limits of natural resources, requires directing productive factors away from the fossil fuel industry. Capital investment decisions are critical in shaping the nature and pace of the transition, and the role of the financial sector is central to this process. Among the different financing instruments, debt financing is key in allocating investment funds, especially because firms cite financial constraints as one of the most important impediments to their investment and growth (Manole & Spatareanu, 2009). Fossil fuel resource extraction is particularly capital-intensive, and these firms traditionally have highly leveraged balance sheets. Therefore, bond markets and banks can either facilitate fossil fuel investments, or, contrarily, channel funds away from the fossil fuel sector.

The transition to a low-carbon economy creates credit risks for the financial sector because it limits the extraction and use of fossil fuel resources by companies to which banks and bondholders may have credit exposures. To meet the Paris Agreement goal to limit global warming to two degrees Celsius or fewer, a major fraction of the world's existing fossil fuel reserves must go unburned (McGlade & Ekins, 2015). This would make obsolete billions of dollars of existing and planned investments in oil, gas, and coal, as companies would leave these resources stranded (Addison, 2018; Carbon Tracker Initiative, 2017). There is a growing consensus that these risks might materialize (Krueger et al., 2019; Meng, 2017). As governments more strictly control carbon emissions, the risk of stranding assets increases, and lenders should require higher interest rates to compensate for the increased default risk; eventually, they may restrict credit to risky borrowers in the fossil fuel sector.

Our paper empirically examines the potentially different roles of market-based versus bank-based credit in the (mis—)allocation of resources to fossil fuel firms. We do so by investigating the cost of corporate bonds versus syndicated bank loan financing for fossil fuel firms and the consequent composition of these two debt types among fossil fuel firms that may strand assets. Moreover, we explore whether bank size and related too-big-to-strand advantages influence how banks react, in terms of lending and risk-taking, to stranding-assets risk.

Because it is difficult to observe when a fossil fuel firm strands its assets, we substitute the risk of stranded assets through a firm-level risk measure of climate policy exposure. This measure is based on the quantity of fossil fuels a firm holds within a specific country and that country's potential willingness to implement stricter climate policies. We construct a hand-collected database with information on firms' fossil fuel reserves. To measure a country's climate policy stringency, we mainly use the Climate Change Policy Index (CCPI) by Germanwatch (Burck et al., 2016). In further analysis, when assessing the financing of fossil fuel firms with oil and gas wells in the United States, we deploy an alternative news-based environmental policy stringency measure. For both the global and US analyses, we use firm-level data that includes new corporate bond and syndicated bank loan financing for fossil fuel firms. We examine syndicated bank loans to estimate bank exposures to fossil fuel firms because large fossil fuel companies rely somewhat less on bilateral bank loans, which are much smaller (Weyzig et al., 2014). 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. Furthermore, a body of literature shows evidence of the substitutability of corporate bonds and syndicated bank loans (Badoer et al., 2019; Becker & Ivashina, 2014; Fabozzi et al., 2019).

In the empirical analysis, we use a difference-difference (DID) approach, where we examine the difference in the response of syndicated bank loan or corporate bond spreads for fossil fuel firms with increased climate policy exposure versus a control group of fossil fuel firms without any fossil fuel reserves and, therefore, no climate policy exposure. In a first step, we find that newly issued corporate bonds in the fossil fuel sector carry higher yields than in other industries. More importantly, we find that with exposure to increasing climate policy stringency, and hence a higher likelihood of stranding reserves, fossil fuel firms pay more in the bond market but not in the syndicated loan market. Hence, fossil fuel firms issue bonds at a relatively higher yield, especially when their reserves are at risk of stranding. This difference is not observable for syndicated bank loans. Further supporting this finding, for the US subsample and the alternative stringency measure, we find that possession of wells is more priced in bond markets. Our finding is consistent with previous evidence on corporate bonds of high-emission firms Seltzer et al. (2022). In contrast, evidence on banks' pricing carbon policy comes from Ivanov et al. (2023), who show that cap-and-trade policy reduces loan maturity and increases loan spreads. However, the affected firms are private firms, with public firms remaining largely unaffected.

To investigate whether this pricing differential in corporate bonds and syndicated bank loans affects how fossil fuel firms acquire external financing, we look at decisions among fossil fuel firms regarding bond versus bank loan issuance. Conditional on the issuance of new debt, firm-level controls, and aggregate loan supply indicators, we find that fossil fuel firms move from corporate bonds to syndicated bank loans in response to changing climate policy exposure (Becker & Ivashina, 2014). Indeed, switching from bonds to loans when the risk of stranding assets increases indicates a contraction in bond supply relative to syndicated bank loan supply for fossil fuel firms. The differential in the pricing of climate policy exposure and the consequential larger allocation of bank credit to fossil fuel implies that banks are less amenable when climate change policies will lead to assets being stranded.

We investigate how incentives to finance fossil fuel firms are distorted and suggest that climate policy exposure may affect the characteristics of the pool of lenders to fossil fuel firms. In particular, we state that large banks with too-big-to-fail incentives are more willing to finance fossil fuel firms at risk of stranding assets because doing so leads to greater lending ex-ante and prevents further losses from divestment. We test this "too-big-to-strand" implication by investigating whether the syndicated bank loan market migrates toward the very largest banks in accordance with a fossil fuel firm's climate policy exposure. Our findings show that there is heterogeneity among banks and that an increase in firms' climate policy exposure increases the proportion of financing from large banks. Moreover, banks that are more likely to receive government support – which we proxy with Fitch Rating's Support Rating Floors (SRFs) – have syndicated bank loan portfolios that contain more climate policy exposure.

Overall, we highlight the negative role large banks play in the global effort to shift away from high-emission activities; this negative role is due to a migration of fossil fuel financing from bonds to banks, to ultimately large banks with too-big-to-strand incentives. The effects we estimate are not only statistically significant but also economically relevant. A one-standard-deviation increase in climate policy exposure implies an increase in bond yield spreads of approximately 6% relative to the mean; we observe no such increase in syndicated loan spreads. Following this, the proportion of external debt financing made up of syndicated bank loans relative to bonds would increase by approximately 7%. Simultaneously, the likelihood that a bank in the top 1/5 percentile in size is involved in a loan increases by 8%.

Our contribution to the literature lies in providing new insights on the role *and the interplay* of two primary sources of debt – public bonds and private bank loans – in climate transition. The relevance of debt financing in the fossil fuel sector and the imminent risk of asset stranding suggests that bond and bank financing both could direct investments away from fossil fuel. Existing literature suggests that market-based financing might be better than bank-based financing to facilitate this transition (De Haas & Popov, 2023). Specifically, it appears that green bonds and fossil fuel divestment have emerged as bottom-up approaches to climate action within the business community. Bolton & Kacperczyk (2022); Meng (2017) find that stock market investors are demanding compensation for their exposure to carbon emissions risk.

Unlike the reaction of markets, fossil fuel firms that are more exposed to climate policy risk do not, on average, pay higher spreads on syndicated bank loans than do similar non-fossil fuel firms or comparable fossil fuel firms. Furthermore, a relevant analysis from the World Resources Institute indicates that from 2016 to 2018, the average annual level of financing for fossil fuel companies from banks with active sustainable finance commitments is still nearly twice the annualized amount of such commitments (Banking on Climate Change, 2019; Pinchot & Christianson, 2019). Moreover,Brown et al. (2017) shows that banking sector development does not necessarily spur growth in innovation-intensive industries, but it has a significant effect on growth in industries with high dependence on external financing. This suggests that the prevalence of private, bank-based credit might privilege fossil fuel firms over the renewable energy sector. Clearly, investments in fossil fuels continue to dwarf investments in renewable energies.

The finance literature has long debated the superiority of the relative merits of market- versus bank-based financing in promoting efficient allocation of risk and funding. Banks' comparative advantage, generally, lies in their ability to collect private information about their borrowers through repeated interaction. However, the procyclicality of the bank credit supply is a source of inefficient allocation of external funding. During asset price booms, banks tend to finance riskier projects, distorting efficient capital allocation, but when asset prices fall, they deleverage (Langfield & Pagano, 2016). Although there is evidence that due to their green preferences banks reallocate syndicated loan credit to firms with lower carbon emissions (Kacperczyk & Peydró, 2021), it may still be the case that – compared to bond markets – banks are less likely to cut fossil fuel financing as long as the value of carbon assets does not sharply slump. In addition, financial markets and banks may differ in how they reallocate credit across and within different industries. Banks' existing knowledge of fossil fuel technology, along with their exposure to carbon assets, are important variables that could explain the relative inefficiency of bank-based versus bond-market-based financing in climate transition (Degryse et al., 2020; De Haas & Popov, 2023). It is also possible that for all these reasons, the largest banks continue to lend to fossil fuel firms, given they are "big-ticket items", while concurrently turning the rest of their credit portfolios toward lower-carbon firms.

When it comes to fossil fuel firms that issue bonds and obtain syndicated loans, our findings suggest that for the large banks that are both underwriters on the bonds and lead managers on the loans, the "direction of "travel" (reflected in price and security involvement) is toward (not away from) the stranding risk present in fossil fuel firms. We find that bank size (more specifically, implicit government support given size) is the main bank characteristic correlated with this direction of travel.

The rest of this paper is organized as follows. Section 2 provides details on the data; section 3 presents the research methodology and results. In section 3.1 we analyze the effect of climate policy exposure on syndicated bank loan and corporate bond credit spreads. In section 3.2 we examine how fossil fuel firms substitute between syndicated bank loans and corporate bonds as a response to changing climate policy exposure. In section 3.2.6 we examine bond-to-bank substitution from the lead bank's perspective. In section 3.3 we examine bank heterogeneity in pricing the risk of stranding assets, along with bank size and the role the potential sovereign support plays. Ultimately, in section 4 we summarize and further discuss our findings.

2 Data

2.1 Climate Policy Exposure

Our main analyses examine whether the use of fossil fuel reserves and the respective risk that firms will strand these reserves is reflected in bond and syndicated bank loan financing patterns. Therefore, ideally, our main explanatory variable would be the amount of the fossil fuel firm's stranded assets, but because this is unobserved, we strictly follow Delis et al. (Forthcoming) and proxy the risk of stranded assets with climate policy stringency. Decarbonization policies involve direct environmental regulations and stimulate technological improvements. Therefore, we assume that the probability of stranded fossil fuel reserves is higher in countries with higher climate policy stringency.

We construct a climate policy exposure variable as the product of a country's climate policy stringency and the relative amount of reserves a firm has in this country. We hand-collect data on the amount and location (by country) of fossil fuel reserves from annual reports.* Table 1 presents an overview of the countries that house the fossil fuel reserves of firms in our sample.

$$\textit{Climate policy exposure (CCPI)}_{t,i} = \sum\nolimits_c \textit{Relative reserves}_{t,i,c} \times CCPI_{t,c} \qquad (1)$$

To measure a country's climate policy stringency, we use mainly the Climate Change Policy Index (CCPI) by Germanwatch (Burck et al., 2016). The CCPI compares countries by their emissions development, emissions levels, renewable energy, efficiency, and climate policies, thus offering a comprehensive view of the current efforts of the countries analyzed. The measure is widely utilized by researchers (e.g., Atanasova & Schwartz (2019); Ehlers et al. (2022), the financial industry (e.g., Blackrock, NN Investment), and policy institutions (e.g., World Bank, Financial Stability Board). In appendix B.4, as part of a robustness check, we will further discuss the climate policy component of the index, which consists

*To construct a unique database of reserve locations, we collect information from annual reports, 10-Ks, or other regulator-required annual information forms. The detailed procedure is in appendix A.

of the national and international policy categories, in more detail.

Figure 1 illustrates the evolution of the climate policy index, CCPI, over time for eight countries. There is a large variation across countries and time.[†] We focus on the fossil fuel industry because much of the global stock of carbon emissions can be traced to the fossil fuel sector. Previous work using firm-level emissions mostly focuses on scope 1 and 2 emissions, and therefore it neglects the role of the fossil fuel sector (Ilhan et al., 2020; Reghezza et al., 2018). Different environmental, social, and governance (ESG) measures lack consistency, and, moreover, Elmalt et al. (2021) shows that ESG scores do not appear to capture differences in emissions growth among large fossil fuel producers, making a cross-firm comparison futile. In order to proxy the risk of stranded assets, we therefore focus on a firm-level indicator that is based on fossil fuel reserves rather than on greenhouse gas (GHG) emissions.

2.2 Corporate Bond and Syndicated Bank Loan Data

Our sample consists of corporate bond and syndicated bank loan data for fossil fuel and non-fossil fuel firms. To retrieve corporate bond data, we collect security identifiers from Thomson Reuters Eikon; subsequently we request bond characteristics via an Excel add-in. We exclude instrument types such as strip bonds, convertible bonds, and capital securities.[‡]

The main characteristics of the same firms' syndicated bank loans (i.e., spread at issue, maturity, and issue amount) are from DealScan.[§] We only keep loan observations of firms that issue at least one corporate bond and syndicated bank loan during 2007-2017. We restrict the analysis to loans originated between 2007 and 2017 due to availability of climate policy data. We further exclude the financial sector from the sample of control firms, as well as debt with maturities of less than a year. Firm-level accounting data is from Compustat, in order to control for firms' specific time-varying characteristics in the regression specifications.[¶]

[†]The publicly available CCPI scores include changes in the calculation methodology in Germanwatch e.V. from 2013 onward. From the Germanwatch team we receive a CCPI data set based on uniform weightings for each index component, for which we are most grateful. However, the CCPI with the old methodology is only available up to 2017.

[‡]Thomson Reuters Eikon provides international deal-level data on new issues of corporate bonds underwritten by an investment bank. The database provides a detailed set of information for each corporate bond issue, including the identity, nationality, and sector of the issuer, as well as the type, interest rate structure, maturity date, rating category of the bond, the amount of, and use of proceeds.

[§]The Loan Pricing Corporation DealScan is the leading source of extensive and reliable information on the global commercial loan market, containing information on over 110,000 global loans, high-yield bonds, and private placements dating back to the mid-1980s.

[¶]Compustat is a database of financial, statistical, and market information on active and inactive large companies around the world dating back to 1962.

Table 2 presents the frequency of retrieved syndicated bank loans and bond issues for 2007-2017. In total we retrieve 18,044 individual loan observations from DealScan. These firms also issue corporate bonds at least once from 2007 to 2017. This sample of loan observations originally from DealScan thus shrinks, as not all observations for loan-level information on debt pricing is available. The final syndicated bank loan sample for the pricing regression consists of 10,428 loan observations, 963 of which are to fossil fuel firms. A syndicated loan is a loan that a group of banks extends jointly, including one (or a few) lead banks and many participant banks. Ordinarily, the lead bank negotiates the key terms of the loan and the participating banks are invited to buy a stake of the loan. Our focus is on the borrower–lender (lead bank) relation when we explore potential heterogeneity among banks in the pricing of climate policy exposure in section 3.3.[‖]

The same set of firms has issued 20,667 corporate bonds, of which 1,341 were to fossil fuel companies, respectively, in the same sample period. Similarly, the sample size shrinks due to the availability of pricing information for 9,323 corporate bond observations, of which 684 are from fossil fuel firms. When a firm issues a bond, a lead underwriting bank, for a fee, buys the bonds from the issuer and sells the bonds to investors, thereby providing insurance for unsold securities and facilitating the sale of the bond. Underwriters can seek partnerships with other banks to share the underwriting responsibilities (Yasuda, 2005). We retrieve lead manager information from Thomson Reuters. Unlike the syndicated bank loans, the number of bond issues for which this information is available is limited.

3 Results

3.1 Climate Policy Exposure and Cost of Debt

3.1.1 Climate Policy Exposure Pricing and Fossil Fuel Credit Allocation

In this section we first examine the relationship between debt financing and stranding assets risks. Second, we discuss how, if banks undervalue the risk of stranding assets, fossil fuel companies are more likely to rely on syndicated bank loans as a substitute for corporate bonds. Third, we examine potential reasons for differential pricing of fossil fuel firms' stranding assets risks between syndicated bank loans and corporate bonds.

[‖] We classify a lender as the lead lender if the variable *Lead Arranger Credit* (provided by LPC's DealScan) takes on the value "Yes" or if the lender is the only lender specified in the loan contract. This often leads to multiple lead banks per loan facility (Streitz, 2016; Sufi, 2007).

The climate transition is a credit risk concern, as climate change exposure increases the possibility of financial losses due to changes in the credit quality of firms in carbon-intensive industries. Therefore, the debt of fossil fuel firms at risk of stranding their assets has higher expected losses (EL). Figure 2 illustrates some parameters of credit allocation toward fossil fuel firms. Let r be the interest rate the lender charges a fossil fuel firm. If the firm defaults, the lender receives no payment. To cover the expected loss EL on a loan, the lender needs to apply an interest rate that also compensates for change in expected loss attributed to the risk of stranded assets. EL is therefore positively correlated with interest rate. We assume that expected loss and return vary across firms and their respective climate policy exposure.

In Figure 2, a debt is created and thereby a fossil fuel investment is made possible in the area that expresses the relationship between expected loss and interest rate. Market allocation is already inefficient if credit is granted on the left side of the risk-free return vertical line. If a bank sets the interest rate in a manner that does not account for the dEL attributed to climate policy exposure, then for a given actual expected loss, EL_0, lenders require interest rate r_1 instead of r_0 from fossil fuel firms. In this case, the area in which firms borrow, and thus the number of loans and fossil fuel investments, would be larger by the red area in Figure 2. A differential in the pricing of the risk of stranding assets between corporate bonds and syndicated bank loans implies that banks continue to finance fossil fuel projects, as the red area space in Figure 2 illustrates, that the bond market does not. This mechanism could mitigate the capital constraints on fossil fuel firms, creating the potential for a reversal of the pecking order.[**]

Increased stranding assets risk as a consequence of climate policy implies higher credit risk. When a fossil fuel firm has high risk of stranding assets, lenders must charge a higher risk premium in order to earn a competitive rate of return. A theoretical literature suggests a number of potential reasons as to why banks may impose different risk premia on fossil fuel debt relative to public debt markets. First, we consider the role of information acquisition and relationship lending. Higher information asymmetry between fossil fuel firms and investors in the corporate debt market could cause them to demand higher interest rate relative to banks who have private information particularly when issuing long-term debt.

[**]The pecking-order theory by Myers and Majluf (1984) applies to capital structure. It predicts that firms prefer to finance new investments with internal funds, followed by low-risk debt such as bank loans. Market-based financing such as corporate bonds and equity are last-resort financing means. This order is explained by the role of asymmetric information, whereby outside investors have less knowledge about the firm than insiders, and they demand a risk premium in their financing. Following this, risky firms may depend more on expensive, market-based financing. If banks do not price climate policy exposure to the same extent as the corporate bond market, the reverse might be the case.

The advantages of relationship lending could make bank debt more attractive for relatively competitive firms with stranding risk (Botsch & Vanasco, 2019; Grimme, 2023). Contrary to this explanation, we find no evidence in later sub-chapters to support the notion that banks are able to identify and favor safer fossil fuel risks when issuing loans. In the sub-section 3.2.6, we investigate whether the choice between loan and bond issuance is driven by the lead bank, respectively, the bond underwriting bank. Additionally, in the sub-section 3.2.4, we consider that green innovators—fossil fuel firms with "green" patents—could be less exposed to climate policy risk.

Secondly, we consider the issue of moral hazard and government guarantees. Government support of banks may facilitate the financing of projects that private banks or markets would be unable or unwilling to finance otherwise (Stiglitz, 1993). When a bank is protected, it may engage in more aggressive behavior by lending to risky fossil fuel firms or offering lower loan rates. Explaining a reduced market discipline compared to markets as creditors anticipate bailouts (Boyd & Gertler, 1994; Schnabel, 2009). In support of this explanation, we find in sub-section 3.3.1 that particularly the largest banks continue to lend to fossil fuel firms where the bond market would not. The risk of stranded assets is primarily concentrated among these large banks, both in terms of volume and concentration. Moreover, banks that are more likely to receive government support – which we proxy with Fitch Rating's Support Rating Floors (SRFs) – have syndicated bank loan portfolios that contain more climate policy exposure (see 3.3.3).

3.1.2 Empirical Identification

To examine whether corporate bonds and syndicated bank loans of fossil fuel firms with climate policy exposure sell for a discount, we regress yield spreads at issue on the interaction between the fossil fuel dummy and climate policy exposure. If the risk of fossil fuel reserves becoming unburnable affects corporate bond and/or syndicated bank loan pricing, then the coefficient of the interaction term should be positive and significant. The basic regression we estimate is:

$$\textit{Cost of debt}_{f,t,i} = a + \beta_1 \textit{Fossil fuel}_{f,t} + \beta_2(\textit{Fossil fuel}_{f,t} \times \textit{Climate policy exposure}_{f,t}) + \lambda I_{i,t} + \gamma F_{f,t} + \epsilon_{f,t,i} \quad (2)$$

For the syndicated bank loan specifications, our main outcome variable is the all-in spread drawn (*AISD*), which equals the spread of the loan facility over LIBOR plus any facility fee. Hence, in equation (2),

$Cost\ of\ Debt$ is the all-in spread drawn of a loan facility i received by borrower f in year t. To examine corporate bond credit spreads, we define $Cost\ of\ Debt$ as the corporate bond benchmark spread at issue, which is the yield differential between the bond redemption yield and the Treasury curve, with maturity and compounding frequency taken into account. $Fossil\ fuel$ is a dummy variable that equals 1 if firm f has a Standard Industrial Classification (SIC) code in the fossil fuel industry and zero otherwise.[††] Firms with non-zero climate policy exposure are as a rule fossil fuel firms; hence, due to collinearity, we can and do not include climate policy exposure in the regression model outside of the interaction term. I is a vector of debt issue-specific characteristics. In the corporate bond regressions, I is a vector of the bond characteristics, bond amount, and bond maturity. In the model with the all-in spread drawn as the dependent variable, we control for the loan amount, the maturity of the loan facility, whether a loan has collateral, the number of lenders in the syndicate, whether a loan has performance pricing provisions, and the number of general covenants. Further, a is a vector of fixed effects. In the corporate bond regression we use the use of proceeds, instrument type, seniority type, and firms' country-year fixed effects. For the syndicated bank loan regression, we similarly use loan purpose, loan type, and bank-year fixed effects. F is a vector of the firm-level controls firm size, leverage, market-to-book ratio, and asset tangibility. ϵ is the error term. All components of the yield spread analysis are described in Table 3.

3.1.3 Estimation Results

We provide summary statistics of key variables used in our analysis in Table 4, panel A for corporate bonds and panel B for syndicated bank loans. Column (3) reports in both panels t-tests of the difference between fossil fuel and non-fossil fuel firms. Panel B shows that the mean all-in spread drawn in our loan sample is 230 basis points (bps), but the mean spread for fossil fuel firms is 250 bps and statistically different from non-fossil fuel firms. Fossil fuel loans are larger, but their average maturity is lower by half a year. In panel A, we observe that newly issued corporate bonds in the fossil fuel industry have on average significantly higher yields relative to non-fossil fuel firms. The overall average mean credit spread at issue is 196 bps, but for the fossil fuel subsample the mean spread is 377 bps. Notably, it is a much bigger difference than what we observe in syndicated loans.

The indicator of whether a bond is secured relies on the variable $Seniority$ from Thomson Reuters Eikon, which represents the order in which the asset is repaid in relation to other asset services by the same entity in the case of liquidation or a significant change to the ownership of servicing entity. Although

[††]The fossil fuel dummy equals 1 if the firms' SIC code from DealScan or TR Eikon is 1200-1400.

the share of loans secured by collateral is larger in the fossil fuel subsample, the reverse is true for bonds. The maturity of bonds is on average twice as long as the maturity of syndicated bank loans. Table 4 indicates that a large fraction of our bond sample is exchange listed. Differences in firm characteristics highlight the structural peculiarities of fossil fuel firms. In either sample the average market-to-book ratio and average leverage of fossil fuel firms are lower relative to non-fossil fuel firms, but fossil fuel firms' asset tangibility is much larger.

Table 6 reports our findings with respect to the pricing of climate policy exposure measured with the CCPI in syndicated bank loans. Specification (1) includes only loan-level controls. To exclude the impact of these potentially "bad controls," specification (2) uses only firm-level controls and the crude oil price; specifications (3) and (4) use the full set of controls. The results are robust with different fixed effects and clustered standard error combinations. Because the lead bank information is largely available, we include bank*year fixed effects. To do so, we only look at loans with at least one leader for the syndicated bank loan pricing regression. Every loan facility is repeated in the data set depending on the number of lead banks. On average a loan has four lead banks. To account for this multiplicity, we cluster the standard errors at the borrower firm level and at the bank level; we adjust the point estimates by weighting each observation by the inversion of their multiplicity, hence 1 over the total number of lead banks per loan. In column (4), we additionally report loan-level clustered standard errors. We do not find any evidence that the syndicated loan market prices climate policy exposure, measured by the CCPI, throughout the period from 2007 to 2014.

Table 5 reports the results of the bond spread regression on climate policy exposure. Firms' country-year fixed effects saturate the model with time-varying supply-side characteristics that are determined by the state of the economy and that might affect spreads. We include instrument type, seniority, and use of proceeds fixed effects to saturate for bond-specific credit risk. Because the latter variables are only sporadically available for bonds, our sample size is further reduced relative to Table 4. Given that the number of bond issues for which there is information on the lead underwriting bank is limited, we are not able to include bank or bank*year fixed effects in the specifications. Although the sample for columns (1)-(3) consists of all retrieved bond observations, in column (4) we look at the subsample of bonds that are exchange-listed. This is to account better for different bondholder characteristics in a public issue of corporate bonds. As in the syndicated bank loan specification, we include the crude oil price as a control, as reduced energy use and prices might magnify the risk of stranded assets.

The regression results in Table 5 show that an increase in climate policy risk exposure results in an increase in corporate bond spreads in 2007-2014. A one-standard-deviation change in climate policy exposure results in an increase on average in the cost of credit of approximately 10 bps, which is equivalent to approximately 4.2% change in the cost of credit relative to the mean in 2007-2014.[‡‡] An example illustrates this further: Canada and Norway both possess substantial quantities of fossil fuels, but because Norway has higher climate policy exposure (CCPI), the probability that the Norway government will strand its assets to meet its carbon dioxide emission target is higher than in Canada. For this reason, for a company that has all its fossil fuel reserves in Canada, the cost of bonds would be lower by over 20 bps in 2014 relative to Norway.

In column (4) we look at the subsample of bonds listed on exchange markets and that make up over 60% of the whole sample. The impact of climate policy exposure on bond pricing is even larger for exchange-listed bonds. A one-standard-deviation increase in climate policy exposure leads to an average increase in cost of credit of approximately 13 bps. A one-standard-deviation increase in climate policy exposure is equivalent to an approximately 5.6% change in cost of credit relative to the mean. This finding potentially highlights the relative importance of retail investors as opposed to institutional investors in pricing climate policy exposure in bonds, considering that institutional investors and dealers are much more dominant in the OTC market (Biais & Green, 2019). First, environmental and sustainability issues are more dominant decision factors for retail investors (Berry & Junkus, 2013). Second, retail investors often trade in smaller amounts, making them less exposed to the risk of devaluing existing fossil fuel legacy positions (Degryse et al., 2020).

3.1.4 Comparing Pre- and Post-2015 Paris Climate Change Agreement

The ratification of the 2015 Paris Climate Agreement is a milestone in international climate politics and therefore offers the opportunity to assess the impact of climate policy on the financial markets (Monasterolo & De Angelis, 2020; Pham et al., 2019). Delis et al. (Forthcoming) finds first evidence of the pricing of climate policy risk in syndicated bank loans after the 2015 Paris Climate Agreement.

In the following, we introduce an interaction to distinguish the periods after 2015 in our bond and syndicated bank loan-pricing estimation models.

[‡‡]The standard deviation for climate policy exposure in the bond sample is 6.4 when debt pricing is available for 2007-2014.

$$\begin{aligned}\textit{Cost of debt}_{f,t,i} = & a + \beta_1 \textit{Fossil fuel}_{f,t} + \beta_2(\textit{Fossil fuel}_{f,t} \times \textit{Post 2015}_t) + \\ & \beta_3(\textit{Fossil fuel}_{f,t} \times \textit{Climate policy exposure}_{f,t}) + \\ & \beta_4(\textit{Fossil fuel}_{f,t} \times \textit{Post 2015}_t \times \textit{Climate policy exposure}_{f,t}) + \\ & \lambda I_{i,t} + \gamma F_{f,t} + \epsilon_{f,t,i} \qquad (3)\end{aligned}$$

Because the topic of climate policy risk has gained more prominence, we could observe that investors start to factor the risk that fossil fuel reserves will become unburnable more into bond pricing for fossil fuel firms. That is, $\beta_4 > 0$, depending on how much more new information the Paris Agreement introduces, respectively, on how much more credible or likely climate policies are.

In Table 7 we do not find evidence of a pricing change for climate policy exposure post-2015 in the bond market. Furthermore, in contrast to Delis et al. (Forthcoming) we do not find convincing evidence that banks start to price the CCPI-based climate policy exposure after the 2015 Paris Agreement. We suggest that the reason for this difference of findings is that our sample consists of firms that have access to syndicated bank loans as well as the corporate bond market. By design, our analysis relies on the least financially constrained firms, which are less affected by contractions in debt supply due to climate policy exposure.

After establishing that there is on average no change in the pricing of corporate bonds or syndicated bank loans after the 2015 Paris-Climate Agreement, in the following sections we look at the sample period 2007 to 2017.

3.1.5 Pooling of Bond and Loan Pricing

In Table 8, we pool the two data sets – corporate bonds and syndicated bank loans – issued by the same firms to estimate the relative climate policy exposure pricing differential.

To account for the key differences in characteristics from a credit risk standpoint between corporate bonds and syndicated bank loans, as also evident in Table 4, we first match the two data sets using a coarsened exact matching approach (Blackwell et al., 2010). We coarsened exact-match bonds and loans on debt maturity, loan amount, secured-dummy, and debt purpose as well as issuer rating. In appendix C, we provide a more detailed description of the matching and consequent regression analysis. To ultimately, compare the pricing between bond and loan observations, we introduce the triple interaction ($\textit{Fossil fuel}_{f,t} \times \textit{Loan-dummy}_t \times \textit{Climate policy exposure}_{f,t}$)

The difference-in-differences estimates we present in appendix Table 8 corroborate that fossil fuel firms' climate policy exposure is priced less in syndicated loans than in bonds. A one standard deviation increase in climate policy exposure implies an increase in bond pricing by approximately 20 bps relative to syndicated bank loan pricing. This difference in pricing is robust to debt characteristics.

3.1.6 US Wells and a News-based Measure of Policy Stringency

To confirm the internal validity of our results, we focus on firms with oil and gas wells in the United States as well as an alternative measure for climate policy stringency. Moreover, US fossil fuel reserves make up a large part of the total sample, warranting an analysis to delve into variations within the US and how much the results might be driven by this. In appendix E, we replicate the results for the US subsample by exploiting the following information: 1) Information on the firms' location of oil and gas wells in different US states, 2) a news-based stringency measure for environmental policy in the US, and 3) information on state-level variation of oil and gas revenue dependency, used as a proxy for the likelihood of regulations affecting fossil fuel reserves to take effect.

3.1.7 Further Robustness Tests

In appendix B, we report several robustness tests with regard to the measure of climate policy exposure. Our results are robust to alternative specifications of the measure, as well as of the regression models. First, we test the robustness of our measure of climate policy exposure to an alternative measure of climate policy stringency. The Climate Change Cooperation Index by Bernauer and Böhmelt (2013) evaluates countries' overall climate policy performance, as well as performance in terms of political behavior and emissions. Second, we construct firms' climate policy exposure based on the CCPI of the headquarter countries in order to investigate the relevancy of the climate policies of countries where firms sell their fossil fuel reserves as opposed to where the their reserves are located. Third, we use past temperature variability in the countries housing fossil fuel reserves as an instrument to correct for potential endogeneity of firms' climate policy exposure to firm characteristics. Fourth, we isolate the impact of national and international climate policy stringency from the other elements of the CCPI.

3.2 Climate Policy Exposure and Bond-to-Loan Substitution

3.2.1 Borrower's Loan-Versus-Bond Choice

The observation that climate policy exposure is priced into corporate bonds indicates that the bond market is less willing than banks are to lend to fossil fuel firms with climate policy exposure. Therefore, bond financing to fossil fuel firms decreases when climate policy exposure increases. To establish this empirically, we investigate fossil fuel firms' external financing. We study whether the risk of stranding assets affects the amount of bond financing compared to syndicated bank loan financing to fossil fuel firms. We assume that changing credit conditions modifies the relative costs between different forms of financing, thus requiring firms to rebalance their debt structures. If the bond market prices climate policy risk higher than the loan market does, *ceteris paribus*, some firms that would issue bonds might instead receive bank loans.

Altunbaş et al. (2010) investigate the financial factors behind the issuance of syndicated loans compared to the corporate bond market. Their main findings are that firms with greater financial leverage, more profits, and higher liquidation values tend to prefer syndicated bank loans. In contrast, firms with more short-term debt and those the market perceives as having more growth opportunities favor corporate bonds. Furthermore, bond financing is a riskier choice for firms. Once a negative signal about a firm's fundamentals occurs, bondholders may want to liquidate their holdings, which reduces the firm's initial net worth. For this reason, risky firms appreciate bank credit because banks are efficient at liquidating assets for troubled firms (Becker & Ivashina, 2014; Bharath, 2002; Bolton & Freixas, 2000). There is also a body of literature providing evidence of the substitutability of corporate bonds and syndicated loans (Crouzet, 2018; Faulkender & Petersen, 2006; Kashyap et al., 1994). However, this literature is largely from the perspective that a bond is a substitute for a loan when the loan supply is tightening.

3.2.2 Estimation Identification

To study firms' substitution between corporate bonds and syndicated bank loans due to climate policy exposure, we again use firm-level data, which includes firms that have access to syndicated bank loans and to the bond market, and that raise new debt financing with a maturity of at least one year between 2007 and 2017. The sample period for this substitution analysis is from 2007 to 2017, when there is a consistent differential pricing for climate policy exposure between the bond and syndicated bank loan markets.

The main dependent variable is the dummy *Loan Versus Bond Choice*. When the dependent variable equals zero, only corporate bonds are issued, and when it equals 1, firms issue only syndicated bank loans. Additionally, to capture partial substitution, we introduce a nonbinary *Loan Versus Bond Choice* variable that also equals 1 if the issue is a loan and zero if the issue is a bond. However, when syndicated bank loans and corporate bonds are issued in the same year, the variable compares the total amount raised through syndicated bank loans in a given year to the total amount of syndicated bank loan and bond funds borrowed in that year. When the non-binary *Loan Versus Bond Choice* variable equals zero, only syndicated loans are issued, and when it equals 1, firms issue only bonds. Any number between zero and 1 indicates a mix of syndicated loan and bond financing. The measures are organized as a panel of firm-year observations and capture firms' (partial) substitution from syndicated bank loans to bonds and vice versa.

We exclude firm-year observations where neither syndicated bank loans nor bonds are issued; this is to rule out a lack of demand for either type of credit (Becker & Ivashina, 2014; Ruggiero, 2018). Thereby, the identification strategy untangles the effect of the demand for and supply of credit in the analysis and rules out the hypothesis that a change in the bonds-to-total-debt ratio is due to lack of credit demand rather than a shrinkage in bond or syndicated bank loan supply.

The empirical specification with this bonds-to-total debt ratio as the dependent variable is the following:

$$\begin{aligned}\textit{Loan versus bond choice}_{f,t} = a + &\beta_1 \textit{Fossil fuel}_{f,t} + \beta_2 \textit{Climate policy exposure}_{f,t} + \\ &\beta_3(\textit{Fossil fuel}_{f,t} \times \textit{Climate policy exposure}_{f,t}) + \\ &\lambda I_t + \gamma F_{f,t} + \delta Z_t + \epsilon_{f,t} \end{aligned} \tag{4}$$

where *a* is a vector of fixed effects and ϵ is the remainder disturbance. *I* represents the variable *Debt Amount*, the total loan and/or bond amount issued in a year. Firm-level variable *F* includes firm size, leverage, market-to-book ratio, and asset tangibility. *Z* represents all wider economy control variables.

To attribute a change in *Loan Versus Bond Choice* to variations in climate policy exposure, we address the alternative explanation of a change in the syndicated loan supply. Theoretical literature and policies that stimulate lending by providing financial support to banks suggests that the bank-loan supply is high in good times and low in bad times. For this reason, it is important to control for syndicated bank credit availability with loan supply indicators. The variable *Non-Performing Loans* indicates, on a country-level, nonperforming bank loans to total gross loans. *Lending Growth* is the growth rate of loans to nonfinancial corporations. We include fixed effects at the firm level in most specifications to capture compositional effects in firms' financing decisions. The literature suggests that being in a certain class of firms with some specific characteristics (e.g. high level of log-assets) is relevant for receiving additional credit. Including firm fixed effects implies that the regression considers only firms that switch from one debt type to another.

3.2.3 Estimation Results

Table 9 contains the summary statistics of the dependent variables. Table 10 presents within-firm evidence on corporate bond-to-syndicated bank loan substitution. To account for potential differences in the nature of bond and syndicated loan issues, we control for the log of the total amount of corporate bonds and/or syndicated bank loans issued in a year. We note, however, that realized outcomes are potentially not optimal controls for borrowers' desired debt amounts. We introduce firm fixed effects to eliminate endogeneity due to unobserved firm characteristics. Hence, in these specifications, we estimate the within-firm effects of climate policy exposure. Because we include firm-fixed effects, the fossil fuel treatment dummy is collinear with the fixed effects; however, the variable does not drop out of the regression model, because few firms change their primary SIC code in the observation period.

The estimations with respect to our explanatory variable of interest, climate policy exposure interaction, show a positive and significant impact in all specifications. The coefficient point estimate in the main specification in column (3) of 0.007 implies that a one-standard-deviation increase in climate policy exposure reduces the fraction of external debt financing from bonds by approximately 7%.[§§] In other words, firms appear to substitute bonds with syndicated bank loans when climate policy exposure is high. Based on this finding, we can for example, *ceteris paribus*, infer that a fossil fuel firm that has fossil fuel reserves in Canada is more likely to issue bonds than is a fossil fuel firm with reserves in Norway. In Table 11 we investigate firms' bond-to-loan substitution while allowing for a partial substitution between the two forms of debt; we observe a similar economic significance.

Overall, we find that when banks assign relatively lower prices to risks related to climate policy exposure compared to the bond market, firms move from bond financing to bank financing. We interpret the bond-to-loan substitution as a measure of the relative misallocation of bank credit relative to bond credit, which is visualized in the red area in Figure 2. The differential pricing encourages fossil fuel firms with climate policy exposure to pursue syndicated bank loans rather than bonds, which further enables fossil fuel capital investments.

Figure 3 depicts the dollar volume of outstanding syndicated bank loans for fossil fuel firms with nonzero climate policy exposure, CPE > 0, from 2007 through 2018. The graph plots the outstanding syndicated bank loans separately for firm subgroups divided into those above and below the median CPE at a given month-year. Furthermore, the graph also shows the increase in the average CPE of fossil fuel

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[§§]The standard deviation for climate policy exposure in this data set is 6.977 for 2007-2017 firms that occured concurrently with increasing regulations Despite the same number of issues in terms of the number of loans, due to the median split, the spread between low and high CPE exposure firms in terms of dollar volume has been significant since around 2013. The volume of loans issued in USD is over 1.5 times larger for firms above the median in terms of the number of loans.

3.2.4 "Green" Innovative Fossil Fuel Firms

Cohen et al. (2020) find that green innovation is largely driven by firms in the energy sector that are generally among the worst performers on environmental issues. This could imply that fossil fuel firms take up credit to finance innovation. Banks' existing knowledge in fossil fuel technology, along with their informational advantage regarding borrowers, could encourage banks to provide more financing to fossil fuel firms that are better in green innovation. To account for green innovation that is otherwise overlooked by our climate policy exposure measure, we explore whether fossil fuel firms' loan-to-bond choices, along with their climate policy exposure, is mediated by their green innovation, which we proxy with firms' green patent output. Our results do not indicate that banks lend more to fossil fuel firms that engage in green innovation (see appendix C).

3.2.5 Bond LIBOR Swap Spread

Typically bonds pay a fixed coupon rate, but loans have a fixed spread over LIBOR. To account for this and in order to ensure comparability of the change in relative costs of syndicated bank loans and corporate bonds, we examine the bond LIBOR swap spread instead of the simple credit spread as a dependent variable (see appendix C).

3.2.6 Banks as Underwriters of Corporate Bonds and Lead Managers of Syndicated Bank Loans

We document a positive relation between the use of bank debt and climate policy exposure. We extend this analysis to examine debt choices from the lead bank's perspective. Differences in underwriter opinions about a firm's riskiness might affect the differential pricing of climate policy exposure in the bond and loan market. If a lead bank lends to a new corporate bond issuer or syndicated bank loan borrower, the private information this lead has obtained through previous loan transactions may give it more precise expectations toward a fossil fuel firm's ability to mitigate its stranded-assets risk (Takaoka & McKenzie, 2006). Therefore, the endogeneity of underwriter choice could lead to better sorting of fossil fuel firms in the syndicated bank loan market.

In order to show that our results on the bond-to-bank substitution are unlikely to arise from differences in banks that underwrite corporate bonds from banks that underwrite syndicated bank loans and ultimately from differences in borrower quality, we undertake the following analysis.

In a first step, we combine the corporate bond and the syndicated bank loan subsets for which the lead manager information is available. We than match lead managers based on name. Following this matching, in our data set the same banks engage in corporate bonds and in syndicated bank loans as lead managers. Table 12 presents an overview of lead managers that have underwritten corporate bonds as well as lead managed syndicated bank loans in our sample during the period 2007-2017.

$$\begin{aligned} \textit{Bank's loan versus bond choice}_{f,b,t,i} = a + & \beta_1 \textit{Fossil fuel}_{f,t} + \beta_2 \textit{Climate policy exposure}_{f,t} + \\ & \beta_3 (\textit{Fossil fuel}_{f,t} \times \textit{Climate policy exposure}_{f,t}) + \\ & \lambda I_{i,t} + \gamma F_{f,t} + \delta B_{b,t} + \zeta Z_t + \epsilon_{f,b,t,i} \end{aligned} \tag{5}$$

The dependent variable *Bank Loan Versus Bond Choice* is a dummy variable that equals 1 if a lead manager bank has underwritten a loan and zero if the lead manager bank has underwritten a bond. Each loan or bond observation can appear more than one time depending on the number of lead manager or underwriter banks per facility. We weigh each observation by 1 over the total number of lead manager or underwriter banks per loan or bond. The *a* variable is a vector of fixed effects, particularly firm fixed effects and lead manager bank fixed effects; ϵ is the remainder disturbance. *I* represents the bond or loan-specific controls debt amount and the maturity. Firm-level variables, *F*, include firm size, leverage, market-to-book ratio, and asset tangibility. *B* is a vector of bank characteristics. Bank controls include the following metrics: basic earning power (BEP) ratio, which equals earnings before interest and taxes (EBIT) divided by total assets; cash over total assets; bank deposits over total assets; and nonperforming assets over total assets. Macro controls, *Z*, include GDP growth, nonperforming loans over total loans, and the lending growth rate.

The estimations in Table 13 show that the coefficient for climate policy exposure interaction is positive and significant with a point estimate of 0.007. For a standard deviation increase in the CCPI, the probability that a bank underwrites a syndicated loan instead of a corporate bond changes by over 5 percentage points. Table 13 therefore indicates that, controlling for bank and firm fixed effects, when a firm's climate policy exposure increases, banks are more likely to underwrite syndicated bank loans than corporate bonds. Hence, our results from Tables 10 and 11 are unlikely to arise from differences in banks' opinion about a given firm's risk.

3.3 Climate Policy Exposure and Large Banks

Banks accumulate fossil fuel exposure that the bond market does not. In fact, fossil fuel exposure is particularly concentrated within large banks.[¶¶][***] A dominant view on why excessive risk-taking could be rational for banks is that they can rely on explicit and implicit bank guarantees such as deposit insurance, central bank liquidity, and government bailouts due to how their failure may affect the national and global economy (Freixas et al., 2000; Morrison, 2011). Large banks that are considered too-big-to-fail (TBTF) may expect to be shielded from the negative consequences of transition risks; therefore they have a greater incentive to take on transition risks compared to bondholders or smaller banks. This could lead to a too-big-to-strand (TBTS) situation where the price of bank loans from large banks does not fully reflect their risk. Banking crises regularly follow periods of strong growth in bank credit and risk-taking (Jorda et al., 2015; Schularick & Taylor, 2012). In the aftermath of the euro area financial crisis and the setting up of a supranational supervisor in Europe, there is some evidence that large banks tend to reduce credit supply to firms with high credit risk (Altavilla et al., 2020). At the same time, banks fall short of expectations with regard to the management and disclosure of their climate-related and environmental risks.[†††]

To establish causation between bank size and climate policy exposure, we first examine whether fossil fuel firms with high climate policy exposure are more likely to receive financing from large banks and the related question of whether bank size mediates the pricing of climate policy exposure. Second, we connect this to the possibility that a bank receives sovereign support if it is in distress. The too-big-to-strand effect predicts that large banks tend to undertake more climate policy risk compared to banks that are not systemically important (Afonso et al., 2014; Kaufman, 2014).

[¶¶] In appendix D, we find no impact from UNEP membership, a proxy for a bank's green preference, on how banks consider climate policy exposure. This is consistent with findings on banks' greenwashing.

[***] Table 14 presents the 20 banks that participated the most frequently in syndicated bank loans to fossil fuel firms with climate policy exposure larger than zero. The list is dominated by the largest banks. Similarly, reports show that even after the Paris agreement in 2015, the largest banks continue to finance fossil fuel firms, implying fossil fuel financing levels are higher in 2020 than in 2016. (Banking on Climate Change, 2019)

[†††] The European Central Bank (ECB) has formulated expectations with regard to bank disclosures in nonbinding guidelines about climate-related and environmental risks; these guidelines were first published in 2020. Among other things, the expectations imply that banks consider fossil fuel exposure risks in their risk appetite framework, when granting credit, and when 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 (European Central Bank, 2022)

3.3.1 Climate Policy Exposure Pricing and Bank Size

We begin by examining whether the effect of climate policy exposure on loan pricing is homogeneous along bank size. The regression is based on equation 2. The outcome variable is again the all-in spread drawn, which equals the spread of the loan facility over LIBOR plus any facility fee to the fossil fuel borrower f and granted by bank b in year t. We define as the main variable of interest the interaction of climate policy exposure and bank size.

In Table 15, we find that across all syndicated loans, bank size decreases the credit spread that lead managers charge. For a fossil fuel firm that borrows from a large bank, a one-standard-deviation increase in climate policy exposure implies a reduction in loan rate of approximately 70 bps compared to a fossil fuel firm borrowing from a small bank.[‡‡‡] These findings are therefore consistent with the exposure estimates discussed earlier. In further unreported analyses, we also show that this discounting is not modulated by bank industry specialization and/or prior engagement with the (fossil fuel) firm in question.

3.3.2 Small-to-Large Banks Substitution

To examine whether fossil fuel firms with high climate policy exposure are more likely to receive financing from large banks, we construct a dependent variable that expresses borrowers' choice between large and small banks. We separate lead manager banks into two size categories using a dummy variable for size, *Large*, which equals 1 in a given year if the firm's total assets are, depending on the specification, either in the top 1/5, top 1/4, or top 1/3 of the distribution of total assets of all lead manager banks in that particular year.[§§§]

Applying equation 4, we obtain the following basic specification:

$$\begin{aligned} \textit{Large versus small bank choice}_{f,t} = a + \beta_1 \textit{Fossil fuel}_{f,t} &+ \beta_2 \textit{Climate policy exposure}_{f,t} + \\ &\beta_3(\textit{Fossil fuel}_{f,t} \times \textit{Climate policy exposure}_{f,t}) + \\ &\lambda I_t + \gamma F_{f,t} + \delta Z_t + \epsilon_{f,t} \end{aligned} \tag{6}$$

‡‡‡[Difference largest and smallest bank size (15.20- 6.15)] * [Standard deviation climate policy exposure] * [Coefficient of the triple interaction]

§§§This table presents an overview of the bank size median (total assets in USD mil.) in the large and not large bank groups.

median top 1/3 vs. median bottom 2/3	2,415,689 vs. 1,069,268
median top 1/4 vs. median bottom 3/4	2,480,411 vs. 1,318,624
median top 1/5 vs. median bottom 4/5	2,521,772 vs. 1,496,633

The main dependent variable is the dummy *Large Versus Small Bank Choice*. When the dependent variable equals 1 a firm receives a loan from a syndication group with at least one lead manager bank in the large group. The variable is 0 when a firm receives a loan from a syndication group without any large lead manager banks. Additionally, a is a vector of firm fixed effects, and ϵ is the remainder disturbance; l represents the variable debt amount, the total loan amount issued in a year i by firm t. Firm-level controls, F, include firm size, leverage, market-to-book ratio, and asset tangibility. Z represents GDP growth and crude oil price annualized.

Table 16 contains the results of the estimation 6. In column (1), we define lead bank managers as large if their total assets are in the top 1/3 of the distribution of total assets of all the lead manager banks in that particular year. In columns (2) and (3) banks are large if they are in the top 1/4 percentile, and in the top 1/5 percentile, respectively. In column (3) the coefficient of the fossil fuel and climate policy exposure interaction implies that a one-standard-deviation increase in climate policy exposure – 7.033 – increases the fraction of syndicated bank loans from banks in the top 1/5 percentile by approximately 8% relative to the mean. In column (2) the coefficient is still positive; however, the effect is smaller and the coefficient is not significant. In column (1) the climate policy exposure interaction coefficient is negative, smaller, and has no significant impact on large versus small bank choice. We conclude that there is substitution toward the very largest lead manager banks along fossil fuel firm's climate policy exposure. The results highlight the importance of considering bank size, as it modifies the effect of climate policy exposure on debt financing in fossil fuel firms. Table 17 contains the results when the dependent variable *Large Versus Small Bank Choice* is nonbinary.

3.3.3 Bank's Weighted Climate Policy Exposure and Potential Sovereign Support

Banks differ in the support they receive from a home-country sovereign. TBTS banks benefit from large explicit and implicit public subsidies, including the expectation that such institutions will receive public support during future emergencies. The probability and magnitude of such support affect the actual risk from bank exposure to fossil fuel. Banks internalize this in their risk assessments, and if they expect government bailouts, then TBTS banks may account for less of the underlying fossil fuel exposure and consequently collect relatively more stranded-assets risk on their balance sheets.[¶¶¶] To establish this, we distinguish whether large banks lend to fossil fuel firms due to perceptions of government support or

[¶¶¶]Future work could consider whether fossil fuel firms in some countries are also too big to strand. In this case, stringency should not matter in bank or bond markets.

due to other size-related factors.

We calculate for each bank the annual weighted climate policy exposure of the fossil fuel firms with positive climate policy exposure to which the bank has provided a syndicated bank loan. This measure serves as a proxy for banks' fossil fuel exposure on the intensive margin (Beyene et al., 2022).

$$\textit{Bank's weighted climate policy exposure}_{b,t} = \sum\nolimits_i \frac{\textit{Loan exposure}_{b,i,t}}{\textit{Total loan exposure}_{b,c}} \times \textit{Climate policy exposure}_{t,i} \quad (7)$$

For our purposes, we want to isolate potential sovereign support for banks from other sources of external support. We rely on the Fitch rating agency's Support Rating Floors (SRFs), a bank-level rating that explicitly measures potential sovereign support independent of the intrinsic credit quality of banks or other external support, such as from institutional owners Afonso et al. (2014); IMF (2022); King et al. (2020). It indicates the conditional probability that a bank will receive government support if it is in distress. In Figure 4, we plot, on the bank-year-level, banks' weighted climate policy exposure along with their bank size and SRFs. On the left side, we plot bank size along with average weighted climate policy exposure. Loans with high climate policy exposure tend to be concentrated among large banks. Furthermore, there is a strong positive relationship between bank size and government support ratings, implying large implicit subsidies for banks that are TBTF, as not all banks are given an SRF. The figure on the right side plots banks' weighted climate policy exposure corresponding to their SRFs. Looking at the subsample of bank-year observations for which SRFs are available, there is a dichotomy. Banks that provide loans to firms with climate policy exposure>0 tend to have either a SRF of A- and higher or, on the other hand, BBB- and NF.

To analyze the effects of government support on banks' lending exposure to fossil fuel climate policy, we regress in columns (1) to (3) in Table 18 banks' SRFs on their climate policy exposure. Banks with high SRFs tend to have higher weighted climate policy exposure in their syndicated bank loan portfolios. For a one-notch increase in SRF, banks' weighted climate policy exposure increases on average by 1.242, whereby the mean for the weighted climate policy exposure is 5.4. In columns (4) to (6) we regress bank size and SRFs on the share of fossil fuel loans of banks' total syndicated loan portfolios in a given year. This is to also observe the change in bank exposure on the intensive margin. For a one-notch increase in SRF, we show that the share of fossil fuel financing increases on average by 0.6 percentage

SRFs use the AAA long-term scale, where AAA ratings indicate an extremely high probability of government support. Where there is no reasonable assumption that sovereign support will be forthcoming, an SRF of 'No Floor'(NF) is assigned which translates to a probability of less than 40 percent. The total number of notches is 21.(Fitch, 2022) points. At the same time, we observe that bank size has a negative, although not significant, impact on banks' fossil fuel financing share. Our results are broadly in line with the TBTS argument that banks with implicit and explicit government support are more likely to take on risky fossil fuel financing. In our view, this is an important result, particularly from a policy perspective.

4 Conclusion

In this paper, we investigate and contrast how market- versus bank-based financing contributes to climate change through its impact on the real economy. We find that the within-firm bond-to-loan substitution, relative to firm-specific credit risk, is an indicator of misallocated bank credit. In the context of the climate transition and fossil fuel firms' risk of stranded assets, our results imply that banks – more than bond markets – are facilitating fossil fuel investments. The monitoring role of banks, generally, should be rewarded with more precise expectations embedded in loan prices. Despite this informational advantage, the differential in the pricing of climate policy exposure and the consequential allocation of credit to fossil fuel implies that banks disregard the likelihood that climate change policies encourage firms to strand assets to a larger extent. We suggest that incentives and expectations related to bank size and too-big-to-strand might lead to further allocation of financing to the fossil fuels sector.

We draw two conclusions. First, market discipline, on its own, is more effective in driving bondholders, rather than banks, to price the negative effect associated with the risk of stranded assets. Second, it is important to recognize debt heterogeneity when looking at how to reduce the financing of carbon-intensive activities. A substitution mechanism between bond and bank financing, or even within the banking industry between financing by large versus smaller banks, could potentially mitigate the capital constraints on fossil fuel firms imposed by the bond market and/or by some more environmentally friendly banks.

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Table 1: The location of fossil fuel reserves

This table presents an overview of the countries housing fossil fuel reserves of the firms in our syndicated bank loan and corporate bond sample.

Country	freq.
Algeria	4
Argentina	14
Australia	45
Azerbaijan	1
Bangladesh	3
Brazil	4
Brunei	1
Bulgaria	2
Canada	393
China	19
Colombia	40
Congo	1
Czech Republic	5
Denmark	5
Ecuador	9
Egypt	23
Equatorial Guinea	4
France	10
Gabon	6
Germany	3
India	27
Indonesia	30
Iraq	1
Ireland	8
Israel	6
Italy	5
Kazakhstan	3
Libya	2
Malaysia	13
Mauritania	3
Mexico	9
Mongolia	4
Morocco	1
Myanmar	1
Netherlands	11
New Zealand	3
Nigeria	4
Norway	34
Oman	1
Pakistan	3
Papua New Guinea	6
Peru	12
Poland	6
Romania	1
Russia	26
South Africa	3
Sudan	2
Syria	2
Thailand	4
Trinidad and Tobago	3
Tunisia	7
Turkey	2
United Kingdom	49
United States of America	767
Venezuela	1
Vietnam	10
Yemen	4

Table 2: Frequency of new debt financing

This table reports the frequency of syndicated bank loans and corporate bond issues in our sample for 2007-2017. Row 1 presents the starting number of syndicated bank loans and corporate bonds. The issuing firms are not in the financial sector and have access to the syndicated bank loan as well as the corporate bond market at least once in 2007-2017. Row 2 presents the subsample of syndicated loans and corporate bonds for which pricing data is available.

		Syndicated bank loans	**Corporate bonds**
1	All observations	18044	20667
	↳ Fossil fuel subsample	1385	1341
2	All observations with pricing data	10428	9323
	↳ Fossil fuel subsample	963	684

Table 3: Overview of variables

This table presents variable definitions and their sources.

Variable	Description	Source
A. Dependent variables		
All-in spread drawn	Sum of the spread over LIBOR plus the facility fee.	Dealscan
Bond spread	Yield differential between the bond redemption yield and the Treasury curve.	Thomson Reuters (TR)
Bond LIBOR swap spread	Difference between the bond-yield-to-maturity at issuance and the LIBOR swap rate matched by closest maturity.	TR
Loan versus bond choice	Equal 1 if new loan is received, zero if new bond is issued per firm-year.	Dealscan and TR
Loan versus bond choice (non-binary)	Equal 1 if new loan is received, zero if new bond is issued per firm-year, and any number between 0 and 1 if a mix of loan and bond financing is received.	Dealscan and TR
Bank's loan versus bond choice	Equal 1 if a lead manager underwrites a syndicated bank loan and zero if a lead manager underwrites a corporate bond.	Dealscan and TR
Large versus small bank choice	Equal 1 if a firm receives a loan from a syndication group with at least one large lead manager bank in the syndication group, zero otherwise.	Dealscan
B. Explanatory variables: Firm characteristics		
Leverage	Ratio of total debt to total assets (times 100).	Compustat
Firm size	Log of total assets in USD.	idem
Market-to-book	Ratio of total assets (book equity value + market equity value) to total assets.	idem
Asset tangibility	Ratio of tangible assets to total assets (times 100).	idem
C. Explanatory variables: Bond characteristics		
Maturity	Bond duration in years.	Dealscan/ TR
Bond amount	Log of nominal amount issued in USD.	idem
Secured	Dummy equal to 1 if the loan is secured.	idem
Exchange-listed	Dummy equal to 1 if the bond is exchange-listed.	idem
Use of proceeds	A series of dummy variables indicating bond use of proceeds (e.g general purpose, capital expenditure, etc.).	idem
Instrument type	A series of dummy variables indicating instrument type (e.g. note, debenture, etc.).	idem
Seniority	A series of dummy variables indicating seniority group (e.g. junior secured, senior unsecured, etc.).	idem
D. Explanatory variables: Loan characteristics		
Maturity	Loan duration in years.	Dealscan/ TR
Loan amount	Log of nominal amount issued in USD.	idem
Collateral	Dummy equal to 1 if the loan is secured with collateral.	idem
Number of lenders	The number of banks involved in the syndicated loan.	idem
Performance provisions	Dummy equal to 1 if the loan has performance pricing provisions.	idem
Number of general covenants	The number of covenants in the loan contract.	idem
Loan purpose	A series of dummy variables indicating loan purpose (e.g. corporate purpose, debt repay, etc.).	idem
Loan type	A series of dummy variables indicating loan type (e.g. term loan, revolver/line, etc.).	idem
E. Explanatory variables: Bank characteristics		
Bank size	Log of total assets in USD.	FitchID
Bank EBIT-over total assets	Basic Earning Power (BEP) ratio which equals the earnings before interest and taxes (EBIT) divided by total assets.	FitchID
Bank cash over total assets	Cash over total assets.	FitchID
Bank deposits over total assets	Deposits (total customers and banks) over total assets.	FitchID
Bank non-performing assets	Non-performing assets (total) over total asset.	FitchID
Support Rating Floor (SRF)	A rating on the 21-point scale that reflects the probability of extraordinary sovereign support.	FitchID
F. Carbon risk related data		
Climate policy exposure	Determined by weighting countries' climate policy index by the relative amount of a firm's fossil fuel reserves in each year in that country. (see equation 1).	Annual reports and climate policy indices
G. Macro Controls		
Crude oil price	Simple average of three spot prices; Dated Brent, West Texas Intermediate, and the Dubai Fateh.	IMF
NPL	Country bank non-performing loans to total gross loans.	WDI
Lending growth	Growth rate of loans granted to non-financial corporations in a country.	WDI
GDP growth	Annual GDP growth rate.	WDI

Table 4: Summary statistics – Corporate bonds and syndicated bank loans 2007-2017.

This table presents summary statistics on key variables.Panel A shows the summary statistics for the corporate bond sample. Panel B presents summary statistics for the syndicated bank loan subsample. Column (1) for the respective whole sample, and column (2) for the fossil fuel sector subsample. Column (3) reports t-tests of the difference between fossil fuel and non-fossil fuel firms. Firm characteristics variables have been winsorized. Firm size and bond and loan amount are in USD and logarithmized. The summary statistics represents all observations for which all debt-level information presented in the table is available (bond spread, bond amount, maturity, exchange-listed, secured, respectively all-in-drawn spread, loan amount, maturity, collateral, number of lenders, number of general covenants).

	Whole sample		Fossil fuel sector		Difference	
	mean	sd	mean	sd	b	t
Panel A: Corporate bonds						
Bond spread (in bps)	195.83	195.87	377.44	246.47	-195.88***	(-20.24)
Bond amount	19.81	0.87	20.11	0.66	-0.32***	(-12.04)
Maturity (in years)	10.43	8.00	10.24	7.20	0.21	(0.71)
Secured	0.10	0.29	0.05	0.23	0.04***	(4.79)
Exchange-listed	0.66	0.47	0.72	0.45	-0.07***	(-3.71)
Firm size	10.83	2.51	9.20	1.76	1.76***	(23.76)
Market-to-book value (in %)	1.59	0.92	1.46	0.73	0.14***	(4.56)
Asset tangibility	83.31	58.96	139.42	50.25	-60.41***	(-28.27)
Leverage	33.43	16.24	28.89	17.39	4.90***	(6.98)
Observations	9298		677		9298	
Panel B: Syndicated bank loans						
All-in-drawn spread (in bps)	229.81	157.74	250.20	160.44	-22.46***	(-4.12)
Loan amount	19.49	1.71	19.88	1.27	-0.43***	(-9.57)
Maturity (in years)	5.02	2.35	4.44	1.52	0.63***	(11.46)
Collateral	0.45	0.50	0.52	0.50	-0.07***	(-4.11)
Number of lenders	10.05	7.76	10.92	8.14	-0.96***	(-3.48)
Performance provisions	0.26	0.44	0.25	0.43	0.01	(0.72)
Number of general covenants	2.21	1.99	2.12	1.65	0.10	(1.73)
Firm size	9.17	2.11	8.78	2.30	0.43***	(5.41)
Market-to-book value (in %)	1.58	0.90	1.48	0.91	0.11***	(3.42)
Leverage (in %)	35.26	19.12	32.03	18.06	3.57***	(5.63)
Asset tangibility (in %)	68.89	47.97	130.27	53.48	-67.66***	(-34.54)
Observations	10316		950		10316	

Table 5: Corporate bond spreads and climate policy exposure (CCPI). Regression results for the period 2007-2014.

The dependent variable is the spread of corporate bonds in bps, and the climate policy exposure is measured by the CCPI. Column (4) contains the subsample of bonds that are exchange-listed. All variables are as defined in Table 3. The lower part of the table denotes the type of fixed effects and clustering used in each specification. For readability, omitted variables due to collinearity are left out.

	Dependent variable: Bond spread			
	(1)	(2)	(3)	(4)
Fossil fuel	130.441***	95.292***	82.424**	32.577
	(3.099)	(2.857)	(2.420)	(0.921)
Fossil fuel*Climate policy exposure (CCPI)	0.523	1.567*	1.473*	1.971**
	(0.446)	(1.786)	(1.670)	(2.012)
Bond amount	-43.674***		39.894***	42.732***
	(-6.361)		(4.924)	(6.099)
Maturity	-1.336***		-0.355	0.167
	(-4.044)		(-1.163)	(0.611)
Firm size		-50.051***	-62.162***	-49.936***
		(-13.290)	(-15.678)	(-14.703)
Market-to-book		-46.347***	-49.295***	-40.850***
		(-7.894)	(-8.398)	(-7.978)
Asset tangibility		-0.358***	-0.304***	-0.203*
		(-3.023)	(-2.610)	(-1.822)
Leverage		2.392***	2.298***	1.945***
		(8.216)	(8.094)	(6.907)
Crude oil price		0.052	0.011	-0.005
		(0.398)	(0.088)	(-0.040)
Constant	1127.703***	740.614***	72.191	-139.708
	(8.198)	(17.017)	(0.497)	(-1.096)
Firm country*Year FE	Yes	Yes	Yes	Yes
Use of proceeds FE	Yes	Yes	Yes	Yes
Instrument type FE	Yes	Yes	Yes	Yes
Seniority FE	Yes	Yes	Yes	Yes
Clustered SE	Firm	Firm	Firm	Firm
Observations	3172	2524	2520	2233
R^2	0.438	0.595	0.604	0.502
R^2_{adj}	0.420	0.580	0.589	0.481

t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 6: Syndicated bank loan spreads and climate policy exposure (CCPI). Regression results for the period 2007-2014.

The dependent variable is the all-in spread drawn in bps of syndicated bank loans and the climate policy exposure is measured by the CCPI. All variables are as defined in Table 3. There can be several loan observations per loan facility for each lead manager in the loan syndicate. To account for this while still including lead bank fixed effects, we weigh each observation by 1 over the total number of lead banks per loan. The lower part of the table denotes the type of fixed effects and clustering used in each specification. For readability, omitted variables due to collinearity are left out.

	Dependent variable: All-in spread drawn			
	(1)	(2)	(3)	(4)
Fossil fuel	24.086**	39.991***	30.634**	30.634***
	(2.435)	(2.752)	(2.365)	(2.975)
Fossil fuel*Climate policy exposure (CCPI)	0.045	-0.091	-0.024	-0.024
	(0.154)	(-0.221)	(-0.062)	(-0.073)
Loan amount	-15.765***		-12.621***	-12.621***
	(-5.919)		(-4.192)	(-4.422)
Maturity	1.176		2.228	2.228
	(0.983)		(1.477)	(1.553)
Collateral	70.378***		55.838***	55.838***
	(13.550)		(8.908)	(10.239)
Number of lenders	-1.312***		-0.872	-0.872*
	(-2.910)		(-1.582)	(-1.734)
Performance provisions	-24.396***		-19.688***	-19.688***
	(-6.776)		(-5.006)	(-5.439)
Number of general covenants	2.716**		1.615	1.615
	(2.534)		(1.493)	(1.630)
Firm size		-14.692***	-7.588***	-7.588***
		(-7.832)	(-3.327)	(-3.548)
Market-to-book		-14.712***	-9.537***	-9.537***
		(-5.452)	(-4.381)	(-5.416)
Asset tangibility		-0.067	-0.026	-0.026
		(-1.073)	(-0.451)	(-0.509)
Leverage		0.713***	0.445***	0.445***
		(3.936)	(2.632)	(2.939)
Crude oil price		0.024	0.026	0.026
		(0.370)	(0.436)	(0.444)
Constant	512.362***	370.938***	522.483***	522.483***
	(10.706)	(17.332)	(10.165)	(10.730)
Bank*Year FE	Yes	Yes	Yes	Yes
Loan purpose FE	Yes	Yes	Yes	Yes
Loan type FE	Yes	Yes	Yes	Yes
Clustered SE	Firm & Bank	Firm & Bank	Firm & Bank	Loan & Bank
Lead banks × loan observations	30218	22295	22119	22119
Observations	5683	4113	4075	4075
R^2	0.612	0.576	0.614	0.614
R^2_{adj}	0.582	0.540	0.581	0.581

t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 7: Corporate bonds, syndicated bank loans and climate policy exposure Post 2015

The dependent variable is the corporate bond spread at issue and the all-in spread drawn, respectively. The climate policy exposure is measured by the CCPI. This table compares the pre- and post-2015 periods. The sample covers 2007-2017. The specifications with regard to control variables and fixed effects are the same as in Table 5, and Table 6 respectively. All variables are as defined in Table 3. The lower part of the table denotes the results for the syndicated bank loan specifications. There can be several loan observations per loan facility for each lead manager in the loan syndicate. To account for this while including lead bank fixed effects, we weigh each observation by 1 over the total number of lead banks per loan. For readability, omitted variables due to collinearity are left out.

	Dependent variable: Bond spread			
Fossil fuel	127.906***	105.357***	93.616**	39.200
	(2.880)	(2.999)	(2.562)	(1.078)
Fossil fuel*Climate policy exposure (CCPI)	0.629	1.255	1.200	1.707*
	(0.529)	(1.396)	(1.300)	(1.764)
Fossil fuel*Post 2015	43.957	-27.614	-28.573	28.170
	(0.576)	(-0.306)	(-0.309)	(0.285)
Fossil fuel*Post 2015*Climate policy exposure (CCPI)	-1.051	0.226	0.337	-0.072
	(-0.549)	(0.113)	(0.164)	(-0.031)
Observations	5048	4209	4202	3684
R^2	0.416	0.579	0.591	0.513
$R^2_{adj.}$	0.399	0.565	0.577	0.495
	Dependent variable: All-in-drawn spread			
Fossil fuel	31.146***	47.997***	38.332***	38.332***
	(3.338)	(3.436)	(3.282)	(3.955)
Fossil fuel*Post 2015	73.343***	62.679***	51.832**	51.832**
	(3.843)	(2.764)	(2.534)	(2.273)
Fossil fuel*Climate policy exposure (CCPI)	-0.063	-0.287	-0.196	-0.196
	(-0.231)	(-0.758)	(-0.579)	(-0.662)
Fossil fuel*Post 2015*Climate policy exposure (CCPI)	0.078	0.028	0.382	0.382
	(0.098)	(0.038)	(0.526)	(0.601)
Lead banks x loan observations	42748	32625	32404	32404
Observations	7788	5857	5813	5813
R^2	0.608	0.583	0.621	0.621
$R^2_{adj.}$	0.579	0.549	0.590	0.590

t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 8: Pooling and matching of loan and bond pricing

This table presents pooled syndicated bank loan and corporate bond regression results. The dependent variable is the corporate bond LIBOR swap spread at issue, and the all-in spread drawn respectively. In column (2) loan and bond observations are matched using the coarsened exact matching method on debt maturity, amount, and a secured-dummy. In column (3) the matching method additionally includes debt purpose. In column (4) the matching method additionally includes debt purpose and borrower rating. All regressions cluster the standard errors at borrower country level.

Dependent Variable: Interest rate spreads (all-in spread drawn and corporate bond LIBOR swap spread)				
	(1)	(2)	(3)	(4)
Fossil fuel	145.946***	80.277***	55.247*	10.333
	(5.906)	(3.074)	(1.751)	(0.498)
Loan-dummy	-77.403***	-181.078***	-169.328***	-178.081***
	(-6.023)	(-9.320)	(-8.418)	(-5.802)
Fossil fuel *Loan-dummy	-159.511***	-83.997***	-63.557***	-49.824
	(-5.655)	(-5.085)	(-3.126)	(-1.124)
Fossil fuel*Climate policy exposure (CCPI)	0.733	1.543***	3.092***	2.538***
	(1.257)	(3.910)	(5.544)	(5.182)
Fossil fuel*Loan-dummy*Climate Policy Exposure (CCPI)	-0.853	-1.938***	-3.360***	-2.776**
	(-1.275)	(-7.055)	(-9.598)	(-2.609)
Debt amount	0.005	0.010	0.009	0.013
	(0.750)	(1.187)	(1.118)	(1.258)
Debt maturity	0.648**	-12.288***	-14.952***	-20.197***
	(2.065)	(-6.194)	(-4.755)	(-5.806)
Secured	130.976***	156.073***	146.032***	114.433***
	(14.411)	(17.049)	(11.705)	(6.891)
Firm Size	-33.057***	-38.565***	-36.867***	-16.813**
	(-7.283)	(-6.794)	(-6.537)	(-2.105)
Market-to-Book	-1.169	-1.038	-0.890*	-0.265**
	(-1.494)	(-1.478)	(-1.948)	(-2.484)
Asset tangibility	-1.234	-0.879	-1.747	3.385
	(-0.451)	(-0.540)	(-0.943)	(0.729)
Leverage	119.795***	161.638***	193.594***	100.496***
	(19.534)	(29.907)	(39.409)	(8.027)
Constant	492.934***	681.191***	665.874***	566.044***
	(10.065)	(8.943)	(7.944)	(4.955)
Year FE	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes
Purpose FE	No	No	Yes	Yes
Borrower rating category FE	No	No	No	Yes
Clustered SE	Firm country	Firm country	Firm country	Firm country
Observations	6056	5923	5210	4639
R^2	0.369	0.546	0.548	0.537
$R^2_{adj.}$	0.363	0.541	0.542	0.531

t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 9: Summary statistics - Loan versus bond choice 2017-2017.

This table presents summary statistics on key variables. Column (1) for the whole sample, and column (2) for the fossil fuel sector subsample. Column (3) reports t-tests of the difference between fossil fuel and non-fossil fuel firms. Loan and bond observations are aggregated on firm-year level. Total debt amount is in USD and has been logarithmized.

	Whole sample		Fossil fuel sector		Difference	
	mean	sd	mean	sd	b	t
Loan versus bond choice	0.63	0.48	0.64	0.48	-0.01	(-0.85)
Loan versus bond choice (non-binary)	0.61	0.45	0.59	0.44	0.01	(1.04)
Average maturity weighted	6.33	4.74	5.83	3.15	0.53***	(5.38)
Total amount	19.35	2.43	20.35	1.42	-1.09***	(-24.32)
Observations	16977		1252		16919	

Table 10: Loan versus bond choice and climate policy exposure (CCPI). Regression results for the period 2007-2017.

This table provides within-firm evidence on corporate bond-to-syndicated bank loan substitution. The table reports the results of the linear regression for the period 2007-2017. The coefficient of interest is the fossil fuel dummy and climate policy exposure (CCPI) interaction term. The dependent variable is equal 1 if the firm receives a new loan in the year, zero otherwise. All variables are as defined in Table 3. The lower part of the table denotes the type of fixed effects and clustering used in each specification. For readability, omitted variables due to collinearity are left out. The coefficients of the variables crude oil price annualized and tangible assets have been scaled by ten for better readability.

	Dependent variable: Loan versus bond choice		
	(1)	(2)	(3)
Fossil fuel	0.034	0.171	0.163
	(0.098)	(0.407)	(0.395)
Fossil fuel*Climate policy exposure (CCPI)	0.007***	0.007***	0.007***
	(9.827)	(7.411)	(6.337)
Total amount	0.056***	0.061***	0.058***
	(3.912)	(4.540)	(4.220)
Crude oil price	0.005**	0.004**	
	(2.689)	(2.587)	
Lending growth rate	0.121	0.170	0.292**
	(0.850)	(1.277)	(2.534)
Non-performing loans	-0.009***	-0.011**	-0.003
	(-2.876)	(-2.523)	(-0.845)
GDP growth	0.008**	0.008*	-0.001
	(2.293)	(1.805)	(-0.271)
Firm size	-0.091***	-0.088***	
		(-4.389)	(-3.611)
Asset tangibility		-0.004	-0.005
		(-1.321)	(-1.615)
Leverage		-0.001	-0.000
		(-1.164)	(-0.816)
Market-to-book		-0.008	-0.020
		(-0.621)	(-1.380)
Constant	-0.572*	0.186	0.299
	(-2.024)	(0.521)	(0.696)
Firm FE	Yes	Yes	Yes
Year FE			Yes
Clustered SE	Firm country	Firmcountry	Firm country
Observations	6948	5901	5901
R^2	0.500	0.512	0.523
$R^2_{adj.}$	0.332	0.336	0.350

t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 11: Loan versus bond choice (non-binary) and climate policy exposure (CCPI). Regression results for the period 2007-2017.

This table provides within-firm evidence on corporate bond-to-syndicated bank loan substitution. The table reports the results of the linear regression for the period 2007-2017. The coefficient of interest is the fossil fuel dummy and climate policy exposure (CCPI) interaction term. The dependent variable non-binary loan versus bond choice equals one if only syndicated bank loans are issued, zero if only bonds are issued, and any number between 0 and 1 is indicating a mix of syndicated loan and bond financing. All variables are as defined in Table 3. The lower part of the table denotes the type of fixed effects and clustering used in each specification. For readability, omitted variables due to collinearity are left out.

	Dependent variable: Loan versus bond choice non-binary		
	(1)	(2)	(3)
Fossil fuel	0.051	0.194	0.189
	(0.159)	(0.486)	(0.480)
Fossil fuel*Climate policy exposure (CCPI)	0.006***	0.006***	0.006***
	(14.585)	(13.069)	(13.653)
Total amount	0.012	0.016	0.015
	(0.796)	(1.183)	(1.036)
Crude oil price	0.003**	0.003**	
	(2.210)	(2.099)	
Lending growth rate	0.184	0.220*	0.303***
	(1.525)	(1.902)	(2.972)
Non-performing loans	-0.005	-0.007*	-0.002
	(-1.495)	(-1.849)	(-0.368)
GDP growth	0.005	0.004	-0.001
	(1.574)	(1.012)	(-0.147)
Firm size		-0.066***	-0.060***
		(-5.108)	(-3.890)
Tangible sssets		-0.005*	-0.005**
		(-1.908)	(-2.440)
Leverage		-0.000	0.000
		(-0.510)	(0.296)
Market-to-book		-0.008	-0.015
		(-0.708)	(-1.172)
Constant	0.267	0.818**	0.838**
	(0.862)	(2.573)	(2.027)
Firm FE	Yes	Yes	Yes
Year FE			Yes
Clustered SE	Firm country	Firm country	Firm country
Observations	9291	7941	7941
R^2	0.398	0.408	0.417
$R^2_{adj.}$	0.248	0.249	0.260

t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 12: Overview of lead manager in the corporate bond and syndicated bank loan market

This table presents an overview of the lead managers that have both underwritten corporate bonds and participated as a lead bank in bank loan syndicates for fossil fuel firms in our sample during the period 2007-2017.

Lead manager	**Bond**	**Loan**	**Total**
ANZ Banking Group	3	89	92
Axis Bank Ltd	4	5	9
BBVA	26	42	68
BMO Capital Markets	51	117	168
BNP Paribas SA	72	265	337
Bangkok Bank	5	8	13
Bank of China Ltd	4	38	42
Bank of Shanghai	1	2	3
Barclays	232	183	415
BofA Securities Inc	326	365	691
CIBC World Markets Inc	15	83	98
CITIC	9	2	11
Capital One Financial Corp	13	18	31
China Construction Bank	2	9	11
Citi	255	348	603
Commerzbank AG	2	55	57
Commonwealth Bank of Australia	2	60	62
Credit Agricole CIB	32	170	202
Credit Suisse	129	88	217
DBS Group Holdings	6	85	91
DNB ASA	18	149	167
Danske Bank	2	17	19
Deutsche Bank	146	112	258
Fifth Third Bancorp	1	1	2
Gazprombank	18	2	20
Goldman Sachs & Co	113	60	173
HDFC Bank Ltd	1	2	3
HSBC Holdings PLC	77	119	196
ICICI Bank Ltd	1	12	13
IMI - Intesa Sanpaolo	12	51	63
ING	6	145	151
Itau Unibanco	2	1	3
JP Morgan	332	437	769
Jefferies LLC	8	9	17
Landesbank Baden-Wurttemberg	2	25	27
Lloyds Bank	1	48	49
Macquarie Group	3	10	13
Mediobanca	6	10	16
Mitsubishi UFJ Financial Group	72	237	309
Mizuho Financial Group	35	8	43
Morgan Stanley	160	62	222
National Australia Bank	1	45	46
Natixis	10	84	94
Nordea	2	61	63
PNC Financial Services Group	14	41	55
RBC Capital Markets	125	25	150
SEB	3	36	39
Santander Corp & Invest Bkg	12	13	25
Sberbank CIB	14	9	23
Scotiabank	46	16	62
Societe Generale	48	97	145
State Bank of India	3	29	32
Sumitomo Mitsui Finl Grp Inc	17	191	208
Swedbank	2	18	20
TD Securities Inc	35	102	137
UBS	61	40	101
UniCredit	20	78	98
United Overseas Bank Ltd	1	30	31
VTB Capital	20	1	21
Wells Fargo & Co	244	283	527

Table 13: Bank's loan versus bond choice and climate policy exposure (CCPI). Regression results for the period 2007-2017.

The dependent variable equals one if a lead manager bank underwrites a syndicated bank loan and zero if the lead manager bank underwrites a corporate bond. The coefficient of interest is the fossil fuel dummy and climate policy exposure (CCPI) interaction term. We weigh each observation by one over the total number of lead manager banks per loan or bond. All firm- and loan-level variables are as defined in Table 3. The lower part of the table denotes the type of fixed effects and clustering used in each specification. For readability, omitted variables due to collinearity are left out. Crude oil price annualized and asset tangibility coefficients have been scaled by ten for better readability.

	Dependent variable: Bank's loan versus bond choice			
	(1)	(2)	(3)	(4)
Fossil fuel	-0.051	-0.113	-0.108	-0.229
	(-0.423)	(-0.966)	(-0.899)	(-1.481)
Fossil fuel*Climate policy exposure (CCPI)	0.007***	0.007**	0.007**	0.006***
	(2.691)	(2.639)	(2.487)	(2.741)
Issue amount	0.038***	0.048***	0.048***	0.085***
	(3.568)	(3.845)	(3.878)	(7.239)
Maturity	-0.022***	-0.023***	-0.023***	-0.020***
	(-11.246)	(-12.021)	(-12.000)	(-9.973)
Firm size	-0.063***	-0.058***	-0.055***	-0.065***
	(-6.398)	(-4.320)	(-3.771)	(-5.210)
Firm asset tangibility	-0.003**	-0.003**	-0.003**	-0.003**
	(-2.473)	(-2.591)	(-2.604)	(-2.275)
Firm leverage	0.001***	0.001***	0.002***	0.002***
	(4.946)	(4.815)	(5.480)	(7.527)
Firm market-to-book	-0.033***	-0.035***	-0.040***	-0.044***
	(-6.615)	(-6.257)	(-6.917)	(-9.139)
Lending growth rate	0.194***	0.199***	0.262***	0.127*
	(3.176)	(3.124)	(3.692)	(1.902)
Non-performing loans	-0.006***	-0.008**	-0.002	-0.004
	(-2.707)	(-2.199)	(-0.598)	(-1.094)
Crude oil price	0.005***	0.007***		
	(6.362)	(9.135)		
GDP growth	0.007***	0.008***	0.001	-0.006*
	(3.260)	(3.440)	(0.403)	(-1.885)
Bank size		-0.092**	-0.032	-0.036
		(-2.643)	(-0.963)	(-1.155)
Bank EBIT-over total assets		0.061	0.152	-0.165
		(0.108)	(0.279)	(-0.329)
Bank cash over total assets		-0.187	-0.107	-0.192
		(-0.728)	(-0.619)	(-1.215)
Bank deposits over total assets		-0.140	0.097	-0.059
		(-1.612)	(0.751)	(-0.383)
Bank non-performing assets		-0.832	-0.606	-0.580
		(-0.727)	(-0.576)	(-0.476)
Constant	0.483**	1.605***	0.731	0.229
	(2.203)	(2.812)	(1.327)	(0.425)
Lead manager FE	Yes	Yes	Yes	
Firm FE	Yes	Yes	Yes	
Year FE			Yes	Yes
Bank*Firm FE				Yes
Clustered SE	Bank	Bank	Bank	Bank
Observations	58808	50995	50995	48903
R^2	0.510	0.499	0.502	0.623
$R^2_{adj.}$	0.496	0.483	0.486	0.555

t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 14: Overview of most frequent fossil fuel lenders

This table presents the 20 banks that have participated the most frequently in syndicated bank loans to a fossil fuel firms with climate policy exposure >0. The sample covers the period 2007-2018.

Bank	Freq.	Percent	Cum.
JP Morgan	153	6.43	6.43
BNP Paribas SA	105	4.41	10.84
Bank of America Merrill Lynch	99	4.16	4.99
BMO Capital Markets Financing Inc	84	3.53	18.52
Wells Fargo & Co	72	3.02	21.55
Royal Bank of Canada	70	2.94	24.49
Wells Fargo Bank NA	69	2.90	27.38
Citibank	62	2.60	29.99
JP Morgan Chase Bank NA	57	2.39	32.38
Bank of America	55	2.31	34.69
Bank of Tokyo-Mitsubishi UFJ Ltd [BTMU]	53	2.23	36.92
Citigroup	53	2.23	39.14
Toronto Dominion Bank	52	2.18	41.33
Bank of Nova Scotia	48	2.02	43.34
Royal Bank of Scotland Plc [RBS]	45	1.89	45.23
Barclays Bank Plc	42	1.76	47.00
HSBC	39	1.64	48.64
Bank of Montreal	35	1.47	50.10
Morgan Stanley	33	1.39	51.49
Sumitomo Mitsui Banking Corp	32	1.34	52.83

Table 15: Bank size and climate policy exposure (CCPI). Regression results for the period 2007-2017.

The dependent variable is the all-in spread drawn, and the climate policy exposure is measured by the CCPI. The sample period is 2007-2017. The coefficient of interest is the fossil fuel dummy and climate policy exposure (CCPI) interaction term. We weigh each observation by 1 over the total number of lead manager banks per loan. The lower part of the table denotes the type of fixed effects and clustering used in each specification. Loan level controls include maturity, loan amount, collateral, number of lenders, performance provisions, and number of general covenants. Firm controls include firm size, leverage, market-to-book, and asset tangibility. Bank controls include EBIT over total assets, market value of equity over book value of equity, cash over total assets, and deposits over total assets. Marco controls include GDP growth rate, lending growth rate, and nonperforming loans. For readability, omitted variables due to collinearity are left out.

	Dependent variable: All-in spread drawn			
	(1)	(2)	(3)	(4)
Fossil fuel	59.744	-34.238	-0.554	90.043
	(0.460)	(-0.394)	(-0.007)	(0.902)
Bank size	-3.468	-5.947**	-5.493**	27.634
	(-1.083)	(-2.368)	(-1.980)	(1.034)
Fossil fuel*Climate policy exposure (CCPI)	9.325**	13.915***	15.466***	13.670**
	(2.027)	(2.980)	(3.043)	(2.259)
Fossil fuel*Bank size	-0.671	5.824	3.429	-3.123
	(-0.075)	(0.938)	(0.652)	(-0.431)
Fossil fuel*Climate policy exposure (CCPI)*Bank size	-0.676**	-0.999***	-1.104***	-0.973**
	(-2.130)	(-3.090)	(-3.126)	(-2.311)
Loan-level controls	Yes	Yes	Yes	Yes
Firm-level controls			Yes	Yes
Bank-level controls		Yes	Yes	Yes
Macro-level controls	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Bank country FE	Yes	Yes	Yes	
Firm country FE	Yes	Yes	Yes	Yes
Bank FE				Yes
Loan purpose FE	Yes	Yes	Yes	Yes
Loan type FE	Yes	Yes	Yes	Yes
Clustered SE	Firm & Bank	Firm & Bank	Firm & Bank	Firm & Bank
Observations	18936	13902	11886	11861
R^2	0.564	0.558	0.557	0.583
$R^2_{adj.}$	0.561	0.554	0.551	0.572

t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 16: Large versus small bank choice and climate policy exposure (CCPI). Regression results for the period 2007-2017.

This table provides within-firm evidence on small-to-large bank loan substitution along firm's climate policy exposure. The table reports the results of the linear probability model for the period 2007-2017. The coefficient of interest is the fossil fuel dummy and climate policy exposure (CCPI) interaction term. The dependent variable equals one if a firm receives a loan from a syndication group with at least one large lead manager bank in the syndication group, zero otherwise. All variables are as defined in Table 3. The lower part of the table denotes the type of fixed effects and clustering used in each specification. For readability, omitted variables due to collinearity are left out. The crude oil price annualized, asset tangibility, and leverage coefficients have been scaled by ten for better readability.

	Dependent variable: Large versus small bank choice		
	Large bank= top 1/3	Large bank= top 1/4	Large bank= top 1/5
	(1)	(2)	(3)
Fossil fuel	-0.384*	-0.396	-0.246
	(-1.788)	(-1.564)	(-1.438)
Fossil fuel*Climate policy exposure (CCPI)	-0.002	0.003	0.005*
	(-0.711)	(1.185)	(1.824)
Total amount	0.082***	0.080***	0.079***
	(3.924)	(3.805)	(3.541)
Market-to-book	0.018**	0.057***	0.073***
	(2.034)	(2.783)	(2.846)
Asset tangibility	-0.001	-0.004	-0.005*
	(-0.449)	(-1.195)	(-1.868)
Firm size	0.069**	0.092**	0.124**
	(2.321)	(2.215)	(2.302)
Leverage	-0.008**	0.002	0.007
	(-2.617)	(0.384)	(1.177)
GDP growth	0.009	0.005	0.023***
	(1.215)	(0.422)	(4.270)
Crude oil price	-0.005*	-0.006*	-0.005
	(-1.727)	(-1.943)	(-1.438)
Constant	-1.606***	-1.933***	-2.392***
	(-4.668)	(-3.835)	(-3.289)
Firm FE	Yes	Yes	Yes
Clustered SE	Firm country	Firm country	Firm country
Observations	6386	6385	6415
R^2	0.642	0.561	0.555
$R^2_{adj.}$	0.524	0.417	0.410

t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 17: Large versus small bank choice (non-binary) and climate policy exposure (CCPI). Regression results for the period 2007-2017.

This table provides within-firm evidence on small-to-large bank loan substitution along firm's climate policy exposure. The table reports the results of the linear probability model for the period 2007-2017. The coefficient of interest is the fossil fuel dummy and climate policy exposure (CCPI) interaction term. The dependent variable equals one if a firm receives a loan from a syndication group with at least one large lead manager bank in the syndication group, zero if the syndication group consists only of small lead banks, and any number between 0 and 1 is indicating a mix of loan financing from syndication groups with at least one and none large lead banks. All variables are as defined in Table 3. The lower part of the table denotes the type of fixed effects and clustering used in each specification. For readability, omitted variables due to collinearity are left out. The crude oil price annualized, asset tangibility, and leverage coefficients have been scaled by ten for better readability.

	Dependent variable: Large versus small bank choice		
	Large bank= top 1/3	Large bank= top 1/4	Large bank= top 1/5
	(1)	(2)	(3)
Fossil fuel	-0.391**	-0.402**	-0.292**
	(-2.291)	(-2.228)	(-2.126)
Fossil fuel*Climate policy exposure (CCPI)	-0.003	0.002	0.005*
	(-0.919)	(0.959)	(1.879)
Total amount	0.086***	0.085***	0.087***
	(4.784)	(4.729)	(4.430)
Market-to-book	0.011	0.052**	0.066**
	(1.442)	(2.572)	(2.537)
Asset tangibility	-0.002	-0.004	-0.004
	(-0.639)	(-1.184)	(-1.678)
Firm size	0.061**	0.085**	0.114**
	(2.168)	(2.205)	(2.153)
Leverage	-0.012***	-0.002	0.003
	(-3.184)	(-0.381)	(0.508)
GDP growth	0.009	0.005	0.023***
	(1.256)	(0.426)	(4.297)
Crude oil price	-0.005	-0.006*	-0.004
	(-1.622)	(-1.790)	(-1.405)
Constant	-1.574***	-1.946***	-2.415***
	(-5.482)	(-4.497)	(-3.557)
Firm FE	Yes	Yes	Yes
Clustered SE	Firm country	Firm country	Firm country
Observations	6976	6976	6976
R^2	0.616	0.539	0.534
$R^2_{adj.}$	0.500	0.401	0.395

t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 18: Bank weighted climate policy exposure and fossil fuel loan share

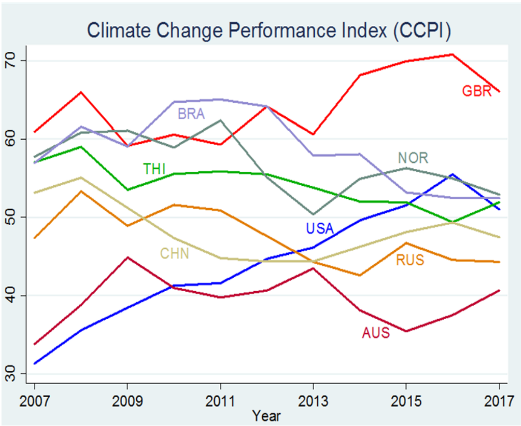
The dependent variable in columns (1)-(3) is the weighted climate policy exposure of fossil fuel firms to which a bank has provided a syndicated loan as lead manager in a given year. The dependent variable in columns (4)-(6) is the share of fossil fuel loans of banks' total syndicated loan portfolio. The sample period is 2007-2017. The lower part of the table denotes the type of fixed effects and clustering in each specification. Bank size is equivalent to *Ln(1+ Total assets)* in USD. Bank controls include EBIT over total assets, market value of equity over book value of equity, cash over total assets, and deposits over total asset. Macro controls include GDP growth rate of bank country.

Dependent variable:	Bank weighted Climate Policy Exposure			Bank fossil fuel share		
	(1)	(2)	(3)	(4)	(5)	(6)
Bank size	2.720***	1.871***	2.359	-0.006	-0.022**	-0.008
	(5.391)	(2.716)	(1.360)	(-0.853)	(-2.241)	(-0.547)
Support Rating Floor			1.242***			0.006***
			(4.020)			(3.917)
Bank controls	No	Yes	Yes	No	Yes	Yes
Bank country controls	No	Yes	Yes	No	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Clustered SE	Bank	Bank	Bank	Bank	Bank	Bank
Observations	2270	1632	347	2255	1451	344
R^2	0.064	0.089	0.272	0.012	0.030	0.147
$R^2_{adj.}$	0.060	0.080	0.234	0.008	0.019	0.102

t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Figure 1: The Climate Change Policy Index (CCPI) development and composition

The Climate Change Policy Index (CCPI) by Germanwatch (Burck et al., 2016) analyzes countries' climate protection performance. The graph on the left side plots the evolution of the CCPI over time for eight countries. The CCPI is based on the categories listed on the right side.



Summary of CCPI Composition

Country coverage	≤58
Time period	2007-2017
Emissions component	Trends, levels
Policy component	Expert assessments
Weighing of emissions relative to policy	80%/20%

Bernauer & Böhmelt (2013)

Figure 2: Credit allocation towards fossil fuel

This figure illustrates the parameters of credit allocation towards fossil fuel firms. An increase in a firms' climate policy exposure implies an increase in the expected loss (EL). If a lender does not account for a firms' climate policy exposure, r_1 instead of r_0 is required from the fossil fuel firm.

Climate policy exposure ⇒ Δ Expected Loss >0

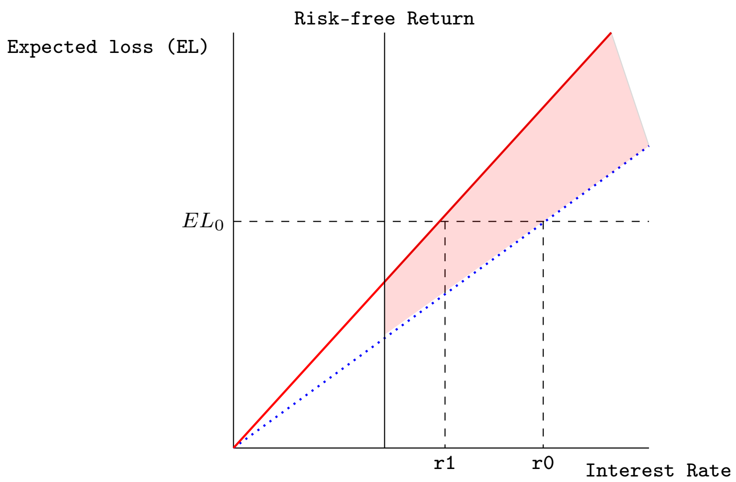


Figure 3: Outstanding volume of syndicated bank loans for CPE > 0

The figure depicts the dollar volume of outstanding syndicated bank loans for fossil fuel firms with CPE > 0 from 2007 through 2018. The graph plots the outstanding syndicated bank loans separately for firm subgroups divided into those above and below the median CPE at a given month-year. The graph also plots the average Firm CPE along the time axis on the right y-axis.

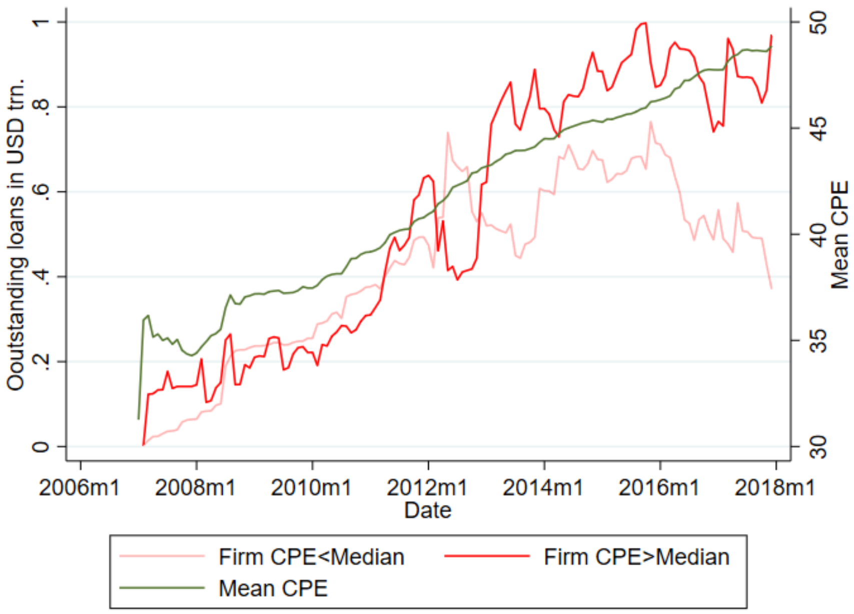


Figure 4: Banks' weighted climate policy exposure, Fitch Support Rating Floors, and size

The figure on the left side plots banks' weighted climate policy exposure along their size. The figure distinguishes bank-year observations for which SRFs are available. The figure on the right side plots banks' weighted climate policy exposure corresponding to their SRFs.