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# The EU Taxonomy and the Syndicated Loan Market

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**Abstract**
The European Union (EU) Taxonomy on Sustainable Activities is one of the most far-reaching financial market regulations to combat climate change. Using international data from the syndicated loan market, we demonstrate that firms with larger EU Taxonomy-eligible revenue shares paid lower interest rates in the years *before* the formal introduction of the Taxonomy. Business revenue is Taxonomy-eligible if it originates from "transitional activities" that substantially contribute to climate change mitigation. A one-standard-deviation increase in firm revenue from transitional activities is associated with 5 basis points (bp) lower loan spreads (5% relative to the standard deviation). Effects are more pronounced for firms in countries with greater climate risk exposure and more stringent environmental policies, and when lending institutions have green preferences. The effects of transitional revenue do not simply reflect a borrower's ESG ratings or broad exposure to climate risks and opportunities. Overall, our results indicate that financial markets already priced in some of the intended effects of the Taxonomy.

**Keywords** EU taxonomy · Climate resilience · Syndicated loan spreads · Climate risk

**JEL Classification** F34 · G12 · G32 · M14 · Q54

## 1 Introduction

The European Union (EU) Taxonomy on Sustainable Activities is one of the most far-reaching financial market regulations to combat climate change. Published on June 22, 2020, it is a cornerstone of the EU's Green Deal, and its objective is to reallocate capital from brown to green firms to achieve carbon neutrality by 2050. The Taxonomy establishes criteria that determine whether an economic activity is environmentally sustainable, which

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is the case if it contributes substantially to one of six environmental objectives. Two of these objectives relate to climate change: climate change mitigation and adaptation.

A core part of the EU's regulatory framework is to mandate firms to report on their sustainability performance against the Taxonomy, as specified in the Corporate Sustainability Reporting Directive (CSRD) and related regulations. Since 2022, financial institutions and large firms in the EU are required to report to what extent their business activities are covered by the Taxonomy ("Taxonomy-eligibility"). As of 2023, firms need to additionally disclose what parts of the covered activities comply with a set of technical screening criteria, while also not significantly harming other Taxonomy objectives ("Taxonomy-alignment"). Starting in 2024, EU banks must disclose lending indicators related to the Taxonomy, such as a Green Asset Ratio (the fraction of taxonomy-aligned assets).[1]

In this paper, we leverage new data from Trucost on the extent to which firms' economic activities are Taxonomy-eligible. Using these data, we test whether lenders in the syndicated loans market priced Taxonomy-eligible revenues of a firm's business activities in the years *prior to* the Taxonomy (2005 to 2018). Our data allow us to identify for each firm the fraction of revenues that originates from Taxonomy-eligible "transitional activities." According to the Taxonomy, such activities must make a substantial contribution to climate change mitigation. An advantage of these data is that they go far back in time.[2] This comes with the limitation that the data do not capture what fraction of a firm's Taxonomy-eligible activities are also Taxonomy-aligned. However, it is unlikely that these specific criteria directly affected the pricing of loans in our sample period. In fact, our sample ends when the EU Commission set up a Technical Expert Group to assist in developing these technical screening criteria.

Our analysis allows us to inform the discussion about the to-be-expected effects of the regulation. Politicians, regulators, investors, and firms have hotly debated about how the Taxonomy will affect capital allocation and the cost of capital of firms. Three broad views have emerged. According to a first view, echoing the regulation's political intent, the Taxonomy will lead to significant reallocations of capital from brown to green firms, thereby increasing (decreasing) the cost of capital for brown (green) activities. Under this view, a taxonomy – combined with mandatory disclosure against it – creates clarity on what constitutes sustainable business activities. Only once this transparency exists, capital providers can reallocate resources and adjust the cost of capital. A prediction of this view is that Taxonomy-eligible business activities are unrelated to syndicated loan pricing in the years before the Taxonomy.

A second view also predicts that loan pricing is unrelated to Taxonomy-linked business activities in the pre-Taxonomy years. The argument here is that the Taxonomy classification is too broad and uninformative about what constitutes a sustainable activity, in turn

[1] Over the next years, the EU's green bond standards will require reporting on whether the use of funds is Taxonomy-aligned, and the Taxonomy may be used to identify climate-related risks of assets and to calculate associated bank capital ratios. Already in 2017, Valdis Dombrovskis, the EU Executive Vice-President and Commissioner for Trade Valdis Dombrovskis, discussed the idea of using the Taxonomy to amend bank capital requirement to incentivize climate-friendly bank lending (Dombrovskis 2017).

[2] Trucost advertised their data by stating that based on these new data, *"financial institutions can start the process of understanding, optimizing, and reporting in line with the EU Taxonomy."* The CEO of Trucost, Richard Mattison, stated that "*Trucost's EU Taxonomy Revenue Share dataset provides a granular assessment of the proportion of company revenues linked to sustainable business activities outlined in the Taxonomy, which help identify climate-linked risks and opportunities across companies and sectors*" (S&P Global 2020).

creating little quality information for investors and mostly a bureaucratic burden. Arguably, this is the result of political lobbying related to some EU member states' industrial policy interests, but also the consequence of interventions by other stakeholders, such as NGOs and lobbying groups.[3]

A third view holds that market participants self-interestedly implemented the gist of the Taxonomy prior to its effective date, either because risk management commands that brown (green) activities are more (less) risky, or because nonfinancial preferences lead to the preferential treatment of green firms. Both channels imply the prediction that investors started to reallocate resources from brown to green activities prior to the Taxonomy, requiring a higher (lower) cost of capital for brown (green) firms. A corollary of this view is that the Taxonomy will have only modest cost of capital effects once it is formally introduced.

Consistent with the third view, our main finding is that firms with larger revenue shares from Taxonomy-eligible transitional activities paid significantly lower loan spreads in the syndicated loan market between 2005 and 2018. We document this result for a global sample of 14,424 loan facilities with borrowers located in 35 countries. A one-standard deviation increase in transitional revenue (scaled by total revenue) is associated with a loan spread reduction of about 5 basis points (bp), or 5% relative to the sample standard deviation. This relationship is robust and varies little in magnitude with the inclusion or exclusion of various fixed effects.[4] The effect of Taxonomy-eligible transitional activities on loan spreads continues to hold when we control for a borrower's ESG ratings, carbon emissions, and climate change exposure. Thus, transitional revenue is neither subsumed by ESG raters' methodologies nor simply a proxy of a borrower's broad exposure to climate risks and opportunities. Instead, there is additional *priced* information content in the measure we use.

The result that we document originates from a risk management *and* a green preferences channel (both channels are not mutually exclusive). To establish the presence of the risk management channel, we show that the effect of transitional revenue on loan spreads is stronger among borrowers from countries with high regulatory and physical climate risks. This finding implies that transitional activities increase a firm's resilience to climate risks, which boosts the credit worthiness and leads to lower cost of debt financing. For the preferences channel, we demonstrate that the loan pricing effects are stronger when at least one lender in the syndicate is a signatory of the Equator Principles (EPs) or of the Principles for Responsible Investments (PRI), two proxies for banks' green preferences.[5] Hence, because of their green preferences, some lenders offer lower interest rates to firms with higher transitional activities.

We conduct a series of further tests to better understand the economic mechanisms of our results, with a focus on the role of *regulatory* climate risks. We analyze shocks to the importance of transitional revenues resulting from the staggered introduction of carbon

[3] For example, the Taxonomy classifies as green activities natural gas and nuclear energy, but also the production of motorboats and sailing yachts. The inclusion of these and other controversial activities has led to significant doubt about the overall quality of the classification system.

[4] We estimate regressions primarily at the syndicated loan level, but results are robust if we estimate regressions at the borrower-loan package level. In these regressions, we replace the loan spread with the mean spread across all facilities of a loan package of a borrower.

[5] By 2022, a total of 128 financial institutions from 38 countries have adopted the EPs, which were launched in 2003 and require that "*financial institutions […] ensure that the projects they finance are developed in a socially responsible manner and reflect sound environmental management practices.*" PRI signatories commit to "*incorporate ESG issues into investment analysis and decision-making processes.*"

taxes across countries. Carbon taxes increase the cost of carbon emissions and provide incentives for firms to engage in green investments. For lenders, they increase regulatory climate risks at high carbon emitters, and they provide incentives to support the financing of green activities. Consistent with these effects playing a role in lending practice, we observe that firms with high transitional revenues benefit from lower loan costs after the implementation of a carbon tax.

If climate risk is indeed a channel through which the risk management results operate, then we expect to see improvements in real environmental outcomes among firms with high transitional activities. Indeed, we demonstrate that transitional revenues positively correlate with firms' future emission reductions, and they positively predict more green innovation.

What do our results imply for the debate about the Taxonomy? First, they demonstrate that the Taxonomy captures meaningful heterogeneity across firms in terms of climate-related risks and opportunities. Second, some of its intended effects may already be priced in, at least in the syndicated loan market.[6] Beyond contributing to the Taxonomy debate, our analysis provides insights into whether, and under what circumstances, green business activities are associated with lower costs of capital in the syndicated loan market. Evidence for this market is crucial, as banks play a central role in financing the green transition.

Our study extends the literature on the lending effects of climate change. Kacperczyk and Peydro (2022) show that high-emission firms borrowing from banks committed to low-carbon lending subsequently receive less credit. Ivanov et al. (2024) exploit shocks to carbon pricing due to cap-and-trade bills in the US. They find that carbon-intensive firms experience shorter debt maturities, lower access to permanent forms of bank debt, and higher interest rates following the pricing shocks. Correa et al. (2023) show that banks anticipate climate-related disasters and demand higher interest rates on loans. Hrazdil et al. (2024) report that loans initiated by firms with adverse climate-related incidents have higher spreads and more restrictive covenants. Kempa et al. (2021) document that the cost of debt of renewable energy firms is lower in countries with stringent environmental policies.[7] Focusing on the pricing of carbon emissions in the syndicated loan market, Ehlers et al. (2022) show that borrowers with higher emissions pay higher spreads. Similar evidence comes from Delis et al. (2024).

We also relate to a nascent literature on the effects of the EU Taxonomy. Closely related is Bassen et al. (2024), who use new data from the FTSE Russell Green Revenues database to document that there is a premium in equity markets for firms with higher Taxonomy-aligned activities. Their evidence is consistent with our results and suggests that investors already apply the gist of the Taxonomy. Dumrose et al. (2022) show that the ESG ratings of several ESG data vendors are positively correlated with Taxonomy-aligned revenues of firms. Alessi and Battiston (2022) develop a method to estimate how financial portfolios align to the EU Taxonomy and apply the method to data from EU investors. A detailed

[6] The eventual effects of the Taxonomy, once fully rolled out, depend on how restrictive and broad it will be applied across firms and financial institutions. Notably, the eventual pricing effects of Taxonomy-*aligned* activities may be stronger than what we document.

[7] In earlier work, Chava (2014) demonstrates that banks charge a higher interest rate on bank loans provided to firms with environmental concerns measured by third-party environmental ratings. We also relate to broader evidence that documents the pricing implications of climate risk for municipal bonds (Painter 2020; Goldsmith-Pinkham et al. 2023) and corporate bonds (Allman 2021; Huynh and Xia 2021; Seltzer et al. 2023). Several studies explore the asset pricing consequences of climate risk in the stock or options market (Choi et al. 2020; Engle et al. 2020; Bolton and Kacperczyk 2021; Ilhan et al. 2021; Hsu et al. 2023).

account of Taxonomy disclosures in Austria and its consequences is provided in Hummel and Bauernhofer (2024).

This paper is structured as follows. Section 2 provides an overview of the EU Taxonomy and its implications for our empirical analysis. Section 3 presents the sample, data, key variables, and summary statistics. Section 4 provides the main results on the effects of transitional revenue on loan pricing as well as robustness tests. Section 5 offers evidence on the economic mechanism behind the results. Section 6 discusses evidence on the corporate real and financial implications of transitional revenue. Section 7 concludes.

## 2 The EU Taxonomy

The EU Taxonomy is the first worldwide framework that provides a comprehensive, economy-wide classifications of sustainable business activities. Published on June 22, 2020, it is a cornerstone of the EU's Green Deal and the objective to achieve carbon neutrality by 2050. The Taxonomy was developed with scientific and technical input from a Technical Expert Group (TEG), which comprised a broad range of stakeholder groups. Though initially developed by the TEG, the final Taxonomy classification is the result of political negotiations and lobbying activities. For example, energy generation from nuclear power and natural gas were only included as sustainable activities in the end and after a long negotiation process, largely because of political interventions by countries relying heavily on these energy sources (the TEG did not include these activities initially). InfluenceMap (2020) documents that lobbying by hundreds of firms and industry groups has led to significant concessions from the EU for the classification of activities related to bioenergy, agriculture, or hydropower. In some cases, this has led to very broad additions of business activities to the Taxonomy, as multiple stakeholders succeeded in adding classifications in bulk (Khan 2020). It has also been argued that some of the regulations were shaped by stakeholders with little business understanding (through the TEG or in subsequent negotiations). Because of these developments, the Taxonomy received significant pushback by business leaders and practitioners, arguing that it is unclear, burdensome, and of little value in terms of delivering climate benefits (Bounds and Hancock 2023). Further, various NGOs criticized that too many of the included activities are fundamentally not sustainable.

The Taxonomy establishes criteria to determine whether an economic activity is environmentally sustainable, which is the case if it contributes substantially to one of six environmental objectives defined in the Taxonomy. Two of these objectives relate to climate change: climate change mitigation and climate change adaptation.[8] The Taxonomy identifies 72 business activities that contribute to climate change mitigation, and 70 activities that help achieve climate change adaptation. At over 550 pages, the Taxonomy specifies the NACE industry codes to which these activities relate to. It also derives additional technical screening criteria for activities in these industries that need to be met if activities are classified as Taxonomy-eligible.[9] Our data do not contain information about whether these criteria are fulfilled, as

[8] The other objectives are sustainable use and protection of water and marine resources; transition to a circular economy; pollution prevention and control; and protection of healthy ecosystems. For these objectives, detailed rules on Taxonomy-aligned activities have not yet been developed.

[9] NACE is a European industry standard classification system. For example, the renovation of existing buildings (NACE codes F41, F43) is only Taxonomy-aligned *"if it leads to a reduction of primary energy demand (PED) of at least 30%."*

this is difficult to construct ex post. Instead, our data measure business activities that potentially fulfill these criteria (they can be considered as Taxonomy-*eligible*).

The Taxonomy splits activities into two sub-categories: transitional and enabling activities. Transitional activities, the focus of our analysis, must contribute to climate change mitigation and a pathway to keeping global warming in line with the Paris Agreement. Enabling activities allow *other* activities to make a substantial contribution to one of the Taxonomy's objectives.[10]

The Taxonomy has major implications beyond the EU as it is widely believed that it will be the benchmark for other countries developing similar classifications. Further, the scope of the regulation covers not only listed and large companies on the EU regulated market but also non-EU firms with substantial activity in the EU. As such, the regulation applies to many firms located outside of the EU. Finally, many non-EU firms and investors outside of the Taxonomy's scope may have to apply the regulations' principles due to peer effects.

## 3 Data

### 3.1 Sample Construction

Our sample is constructed in the intersection of three datasets: (1) Refinitiv's DealScan dataset on syndicated loans; (2) S&P Global's Trucost Taxonomy Revenue Share dataset on Taxonomy-eligible transitional and enabling revenue; and (3) Refinitiv's Worldscope dataset on firms' financial characteristics. We first merge syndicated loans data from DealScan with financial data from Worldscope using ISINs, which provides us with 58,995 loan-facility observations.[11] We then merge these data with the Trucost database (using ISINs). We drop observations with negative loan spreads and with missing information on the syndicated loan variables or firm characteristics used in the analysis. We also drop observations from countries with less than 20 observations. The final sample consists of 14,428 loan facilities between 2005 and 2018 with borrowers from 35 countries.[12] Variables are defined in Appendix 1.

### 3.2 EU Taxonomy Variables

The Trucost dataset identifies the share of revenues associated with a firm's transitional and enabling activities, going back in history until 2005. Trucost first matches the NACE codes of activities linked to the Taxonomy with the business activities classified by the North American Industry Classification System (NAICS). It then calculates the proportion of firm revenue

[10] The difference between the two revenue types can be explained with an example. While using solar panels as a power source is viewed as a transitional activity, the production of the panels is an enabling activity. Transitional activities are only identified within the category "climate change mitigation," while enabling activities are in "climate change mitigation" and "climate change adaptation." Not all Taxonomy-linked activities on climate change mitigation receive the transitional activity label (and accordingly for enabling activities).

[11] We thank Michael Roberts for sharing the DealScan linking table developed based on Chava and Roberts (2008).

[12] Trucost uses fiscal year-end information to calculate transitional revenues. Their sample coverage starts with fiscal years that end in 2005. We match fiscal year-ends to calendar years by treating a fiscal year-end date before July 1 of year *t* as belonging to calendar year *t-1*. Thus, our sample includes some Trucost data for calendar year 2004. Our regressions used lagged values of transitional revenues, implying that the sample period for the regressions using loan data is still 2005 to 2018. We assume that banks can only observe Taxonomy-eligible revenue published three months before the starting date of a syndicated loan facility.

generated by NAICS-based business segments with transitional or enabling activities. Trucost covers over 15,000 listed firms and represents, according to the data provider, 98% of global market capitalization. We use two variables related to the Taxonomy. Our main variable of interest, *Transitional Rev*, is the fraction of a firm's revenue associated with economic activities that make a substantial contribution to climate change mitigation based on a firm's activities. Some of our tests use *Enabling Rev*, which represents the revenue arising from economic activities that enable other firms to contribute to the EU's climate change objectives (e.g., they manufacture components or provide services that improve the environmental performance of other activities). We focus on transitional revenue as it most directly affects a firm's own climate risk (enabling activities primarily reduce other firms' climate risks).

### 3.3 Syndicated Loan Variables

We use data on syndicated loan facilities from DealScan. As in prior literature, we use the all-in-spread-drawn on a loan facility (*Loan Spread*) as our main variable to measure the cost of a loan (Qian and Strahan 2007; Campello and Gao 2017). The all-in-spread-drawn is the annual interest rate spread paid over LIBOR plus upfront fees for each dollar drawn down from the loan. Our tests also use data on the loan amount, the loan maturity, the number of covenants, the number of lenders in a syndicated loan, information on performance pricing, whether a loan has a guarantor, whether the loan is a revolver, the loan term, and whether a loan is secured.

### 3.4 ESG Ratings and Climate Change Variables

As the Taxonomy classification may overlap with the methodology of ESG raters, we examine whether and how our estimates change when we control for borrowers' ESG rating scores. We make use of two ratings: (i) *ESG Rating MSCI* is the ESG rating score from MSCI IVA, and (ii) *ESG Rating Asset4* is the ESG rating score from Refinitiv's Asset4. For both ratings, a higher score indicates better ESG performance.

Business revenue arising from green investments may be motivated by a firm's need to reduce carbon emissions, which constitute a source of transition risk. To control for this driver, we follow Bolton and Kacperczyk (2021) and use data on carbon emissions from Trucost as a proxy for climate transition risk. *Log Scope 1 Emissions* is the logarithm of Scope 1 carbon emissions, and *Log Scope 2/3 Emissions* is the logarithm of the sum of Scope 2 and 3 emissions.

To evaluate whether the Taxonomy captured all activities related to a borrower's climate change exposure, not just carbon emissions, we control in some tests for measures of a borrower's exposure to climate change opportunities ($CCExposure^{Opp}$) and physical and regulatory shocks associated with climate change ($CCExposure^{Phy}$, and $CCExposure^{Reg}$). These measures are from Sautner et al. (2023) and constructed from earnings conference calls.

### 3.5 Firm-Level Control Variables

Our regressions account for a battery of firm characteristics, such as firm size (*Log Assets*), return-on-assets (*ROA*), financial leverage (*Leverage*), asset tangibility (*Tangibility*), and

**Table 1** Descriptive statistics. Note: this table reports the summary statistics at the loan-facility level of the variables used in the main analysis (Table 2, column 1). The only exception is *Package Loan Spread*, which is at the borrower loan-package level (for the sample in Table 3, column 5). Variable definitions are reported in Appendix 1

| Variables | Mean | Std. Dev. | 5% | Median | 95% | # Obs. |
|---|---|---|---|---|---|---|
| $Loan\ Spread_{i,j,c,t}$ | 159.2 | 107.1 | 30.0 | 137.5 | 370.0 | 14,428 |
| $Package\ Loan\ Spread_{i,j,c,t}$ | 150.2 | 103.9 | 25.0 | 125.0 | 350.0 | 9,894 |
| $Transitional\ Rev_{j,c,t-1}$ | 0.227 | 0.379 | 0 | 0 | 1 | 14,428 |
| $Enabling\ Rev_{j,c,t-1}$ | 0.138 | 0.309 | 0 | 0 | 1 | 14,428 |
| $ESG\ Rating\ MSCI_{j,c,t-1}$ | 4.802 | 1.370 | 2.690 | 4.700 | 7.240 | 9,051 |
| $ESG\ Rating\ Asset4_{j,c,t-1}$ | 43.327 | 18.936 | 14.300 | 42.635 | 75.743 | 11,053 |
| $Log\ Scope\ 1\ Emissions_{j,c,t-1}$ | 11.739 | 2.879 | 7.453 | 11.439 | 17.189 | 12,912 |
| $Log\ Scope\ 2/3\ Emissions_{j,c,t-1}$ | 12.625 | 1.949 | 9.439 | 12.651 | 15.857 | 12,912 |
| $CCExposure^{Opp}{}_{j,c,t-1}$ | 0.399 | 1.207 | 0 | 0.040 | 2.253 | 10,937 |
| $CCExposure^{Phy}{}_{j,c,t-1}$ | 0.066 | 0.253 | 0 | 0 | 0.360 | 10,937 |
| $CCExposure^{Reg}{}_{j,c,t-1}$ | 0.014 | 0.091 | 0 | 0 | 0.081 | 10,937 |
| $Log\ Loan\ Amount_{i,j,c,t}$ | 19.758 | 1.380 | 17.284 | 19.847 | 21.822 | 14,428 |
| $Log\ Loan\ Maturity_{i,j,c,t}$ | 3.813 | 0.613 | 2.565 | 4.111 | 4.443 | 14,428 |
| $Loan\ Covenants_{i,j,c,t}$ | 0.715 | 1.074 | 0 | 0 | 3 | 14,428 |
| $Log\ \#\ Lenders_{i,j,c,t}$ | 2.272 | 0.723 | 0.693 | 2.303 | 3.367 | 14,428 |
| $Performance\ Pricing_{i,j,c,t}$ | 0.229 | | | | | 14,428 |
| $Guarantor_{i,j,c,t}$ | 0.111 | | | | | 14,428 |
| $Revolver_{i,j,c,t}$ | 0.531 | | | | | 14,428 |
| $Inst\ Tranche_{i,j,c,t}$ | 0.068 | | | | | 14,428 |
| $Secure_{i,j,c,t}$ | 0.286 | | | | | 14,428 |
| $SP\ Rating_{i,j,c,t}$ | 0.527 | | | | | 14,428 |
| $Log\ Assets_{j,c,t}$ | 22.897 | 1.591 | 20.491 | 22.746 | 25.737 | 14,428 |
| $ROA_{j,c,t}$ | 0.060 | 0.076 | −0.023 | 0.053 | 0.166 | 14,428 |
| $Leverage_{j,c,t}$ | 0.322 | 0.187 | 0.039 | 0.304 | 0.633 | 14,428 |
| $Tangibility_{j,c,t}$ | 0.325 | 0.272 | 0.007 | 0.256 | 0.845 | 14,428 |
| $Tobin's\ Q_{j,c,t}$ | 1.656 | 1.005 | 0.905 | 1.351 | 3.371 | 14,428 |

stock market valuation (*Tobin's Q*). The selection of these variables centers around proxies for firm profitability and credit constraint for two reasons: (i) these factors are key determinants of loan pricing (Sufi 2007; Qian and Strahan 2007; Saunders and Steffen 2011); and (ii) environmental performance can be driven by credit constraints (Bartram et al. 2022; Xu and Kim 2021).

### 3.6 Summary Statistics

Table 1 reports descriptive statistics at the loan-facility level. The mean values of *Transitional Rev* and *Enabling Rev* are at 22.7% and 13.8%, respectively. More than half of all firms have zero transitional revenue related to activities of the Taxonomy; this indicates that many firms are still at an early stage of climate transitioning. *Loan Spread* has a mean value of 159 bp, with a standard deviation of 107 bp. Internet Appendix (IA) Table 1 reports *Transitional Rev* and *Enabling Rev* by country.

# 4 Empirical Results

## 4.1 Transitional Revenue and the Cost of Borrowing

We start the analysis by establishing that firms with higher revenue shares from Taxonomy-eligible transitional activities pay lower loan spreads in the syndicated loan market. This negative relationship can originate from a financial (risk management) channel or a nonfinancial (green preferences) channel. The first channel holds that transitional activities increase a firm's resilience to climate risks, which boosts the credit worthiness and leads to lower cost of debt financing. The second channel instead holds that lenders are willing to offer lower interest rates because of their green preferences. Before exploring these channels, we establish the baseline relation between loan spreads and transitional activities by estimating the following regression at the loan-facility level:

$$Loan\ Spread_{i,j,c,t} = \alpha + \beta\ Transitional\ Rev_{j,c,t-1} + \delta'\ \boldsymbol{X}_{i,j,c,t} + \theta_t + \gamma_c + \varepsilon_{i,j,c,t}, \quad (1)$$

where $Loan\ Spread_{i,j,c,t}$ is the interest rate spread on loan facility $i$ of firm $j$ in country $c$ and year $t$, and $Transitional\ Rev_{j,c,t-1}$ is firm $j$'s revenue share from Taxonomy-eligible transitional activities in year $t$-$1$. The coefficient of interest is $\beta$, which measures the effect of transitional revenues on loan spreads. $\boldsymbol{X}_{i,j,c,t}$ includes a series of controls at the loan-facility and firm level. At the loan-facility level, we control for *Log Loan Amount*, *Log Loan Maturity*, *Loan Covenants*, *Log # Lenders*, *Performance Pricing*, *Guarantor*, *Revolver*, *Inst Tranche*, *Secure*, and *SP Rating*. At the firm level, we control for *Log Assets*, *ROA*, *Leverage*, *Tangibility*, and *Tobin's Q*. We saturate the model with fixed effects at the loan purpose, year, country, industry, and industry-by-year level, respectively (indicated accordingly). Standard errors are clustered at the borrower level. We also estimate Eq. 1 at the borrower-loan package level (as our main independent variables vary at that level), whereby we replace *Loan Spread* with *Package Loan Spread* (mean spread across all facilities of a loan package of a borrower).

The estimation results of Eq. 1 are presented in Table 2. In column 1, the coefficient of *Transitional Rev* is negative and highly statistically significant, after absorbing loan purpose, country, and year fixed effects. The estimate indicates that banks charge lower spreads for firms with a higher proportion of transitional revenue. A one-standard deviation increase in *Transitional Rev* (0.379) is associated with a loan spread reduction of about 5 bp, or 5% relative to the variable's sample standard deviation (107.1 bp). Using a back-of-the-envelope calculation, the estimated percentage decrease in loan cost can be converted to about \$6.2bn cost savings (the total amount of syndicated loans in the sample is about \$12.4tr).

In column 2, we add *Enabling Rev* to the estimation. While the coefficient of *Transitional Rev* remains negative, statistically significant, and largely unchanged in size, the coefficient of *Enabling Rev* is positive (but statistically insignificant). One interpretation is that lenders focus on business activities that directly address a firm's own climate risk when pricing syndicated loans (this may be the case because of both channels).

The next columns evaluate the robustness of these results. As certain industries tend to be inherently greener than others, we add industry fixed effects in column 3. To further saturate the model, in column 4 we account for industry-by-year fixed effects (to ensure that transitional revenue does not simply pick up time-varying industry shocks). In columns 3 and 4, the coefficient of *Transitional Rev* changes only slightly in size and remains statistically significant. That the estimates vary little across the fixed effects specifications

**Table 2** Transitional revenue and syndicated loan spreads: baseline results. Note: this table reports in columns 1 to 5 regressions at the loan-facility level relating transitional revenue (*Transitional Rev*) and enabling revenue (*Enabling Rev*) to syndicated loan spreads (*Loan Spread*). In column 6, we report regressions at the borrower-loan package level using *Package Loan Spread* as the dependent variable, which is the mean spread across all facilities of a loan package of a borrower. Intercepts are included but not reported. Column 1 to 4 and 5 report regression results using the full sample. Column 6 reports the regression results using "grey" industries only. Variable definitions are reported in Appendix 1. Standard errors, reported in parentheses, are clustered at the borrower level

| Dependent variable | $Loan\ Spread_{i,j,c,t}$ | | | | $Package\ Loan\ Spread_{i,j,c,t}$ | $Loan\ Spread_{i,j,c,t}$ |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| $Transitional\ Rev_{j,c,t-1}$ | −14.268*** | −12.897*** | −17.227*** | −15.828*** | −12.059*** | −47.430*** |
| | (4.000) | (4.084) | (5.430) | (6.012) | (3.740) | (17.362) |
| $Enabling\ Rev_{j,c,t-1}$ | | 6.515 | | | | −3.615 |
| | | (4.587) | | | | (18.511) |
| $Log\ Loan\ Amount_{i,j,c,t}$ | −4.234*** | −4.265*** | −5.893*** | −4.958*** | −4.078*** | −5.233 |
| | (1.065) | (1.066) | (1.091) | (1.088) | (1.298) | (6.347) |
| $Log\ Loan\ Maturity_{i,j,c,t}$ | 3.955** | 3.803* | 3.653** | 6.761*** | 2.026 | 14.531* |
| | (1.963) | (1.952) | (1.858) | (1.955) | (2.115) | (7.919) |
| $Loan\ Covenants_{i,j,c,t}$ | 1.049 | 1.055 | 1.056 | 1.395 | 1.257 | −6.127 |
| | (1.235) | (1.237) | (1.179) | (1.282) | (1.169) | (5.941) |
| $Log\ \#\ Lenders_{i,j,c,t}$ | −4.583** | −4.541** | −5.061*** | −7.618*** | −2.285 | −7.875 |
| | (1.797) | (1.793) | (1.638) | (1.744) | (1.865) | (6.795) |
| $Performance\ Pricing_{i,j,c,t}$ | −4.158* | −4.111 | −3.621 | −5.218* | −2.271 | 10.405 |
| | (2.504) | (2.513) | (2.465) | (2.848) | (2.213) | (10.677) |
| $Guarantor_{i,j,c,t}$ | −1.275 | −1.266 | −1.792 | 1.630 | −0.729 | −6.461 |
| | (2.979) | (2.982) | (3.042) | (3.399) | (2.910) | (14.867) |
| $Revolver_{i,j,c,t}$ | −18.797*** | −18.890*** | −18.553*** | −17.196*** | −21.009*** | −28.637*** |
| | (2.073) | (2.073) | (1.920) | (1.970) | (2.930) | (8.959) |
| $Inst\ Tranche_{i,j,c,t}$ | 66.949*** | 67.064*** | 65.035*** | 55.934*** | 91.239*** | 38.064* |
| | (5.595) | (5.584) | (5.329) | (5.288) | (7.759) | (22.342) |
| $Secure_{i,j,c,t}$ | 46.166*** | 46.141*** | 38.258*** | 38.213*** | 42.947*** | 48.416*** |
| | (3.146) | (3.144) | (3.162) | (3.546) | (3.260) | (11.903) |

**Table 2** (continued)

| Dependent variable | *Loan Spread*$_{i,j,c,t}$ | | | | *Package Loan Spread*$_{i,j,c,t}$ | *Loan Spread*$_{i,j,c,t}$ |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| *SP Rating*$_{i,j,c,t}$ | −10.310*** | −10.281*** | −12.519*** | −13.654*** | −9.290*** | −1.265 |
| | (3.060) | (3.052) | (3.007) | (3.308) | (3.035) | (12.908) |
| *Log Assets*$_{j,c,t}$ | −11.197*** | −11.198*** | −11.728*** | −11.366*** | −11.981*** | −18.048*** |
| | (1.019) | (1.015) | (1.281) | (1.385) | (0.995) | (5.990) |
| *ROA*$_{j,c,t}$ | −76.276** | −76.485** | −77.825** | −65.568 | −75.845* | 53.643 |
| | (34.268) | (34.243) | (36.039) | (47.505) | (41.096) | (75.522) |
| *Leverage*$_{j,c,t}$ | 57.729*** | 56.547*** | 69.748*** | 74.757*** | 56.008*** | 148.501*** |
| | (7.291) | (7.226) | (7.633) | (8.190) | (6.648) | (35.125) |
| *Tangibility*$_{j,c,t}$ | 2.079 | 1.650 | −12.333 | −10.169 | 2.877 | 27.818 |
| | (5.397) | (5.421) | (8.582) | (8.597) | (5.023) | (23.817) |
| *Tobin's Q*$_{j,c,t}$ | −11.226*** | −11.186*** | −10.620*** | −10.967*** | −11.203*** | −23.134** |
| | (1.745) | (1.742) | (1.770) | (2.170) | (1.802) | (9.550) |
| Loan purpose fixed effects | Yes | Yes | Yes | Yes | Yes | Yes |
| Year fixed effects | Yes | Yes | Yes | Yes | Yes | Yes |
| Country fixed effects | Yes | Yes | Yes | Yes | Yes | Yes |
| Industry fixed effects | No | No | Yes | No | No | No |
| Industry x Year fixed effects | No | No | No | Yes | No | No |
| # Obs. | 14,428 | 14,428 | 14,397 | 13,452 | 9,894 | 844 |
| Adj. $R^2$ | 0.505 | 0.505 | 0.553 | 0.614 | 0.508 | 0.581 |

*, **, and *** indicate statistical significance at 10%, 5%, and 1%, respectively

suggests that unobserved heterogeneity correlated with these fixed effects dimensions does not unduly affect our point estimates. In column 5, we report the effect of transitional revenue on loan spreads at the loan package level, calculated as the average spread across all facilities of a loan package. We use the averages of loan characteristics across facilities within a loan package as package-level characteristics.[13] Our results remain unaffected at the borrower-loan package level.

In column 6, we investigate how credit markets priced "grey" activities. As mentioned, a concern with the Taxonomy is that the classification has become too broad, with stakeholder and lobbying groups having added classifications in bulk and industrial policy considerations having replaced science-based arguments (Khan 2020). For example, the Taxonomy classifies as green activities the production of light trucks or scooters, natural gas, or nuclear energy. These classifications not only raise the question whether these activities can have a material impact in mitigating or adapting to climate change, but also whether lenders price these activities differently from activities where there is less disagreement about the "greenness."

While we are unable to use a granular firm-level metric of the "greyness" of a firm's activities, we can conduct an analysis among borrowers in "grey industries."[14] Column 6 shows that the effect of transitional revenue on loan spreads also holds for borrowers in such industries. A one-standard-deviation increase in *Transitional Rev* within this subsample is associated with a decrease in loan spreads of about 15 bp or 12% of the standard deviation; the size of this effect is larger than what we obtained in the overall sample. An interpretation is that lenders broadly agree with the Taxonomy's classification of these activities and are particularly eager to provide loans to borrowers with high Taxonomy-eligible revenues in relatively dirty sectors (e.g., by lending to oil majors with relatively high revenue shares from natural gas). However, our greyness measure may be too broad to provide a conclusive assessment of the pricing of grey activities. More research is needed to provide a granular analysis of grey activities.

The control variables have the expected signs and line up with those documented in prior literature (Sufi 2007; Qian and Strahan 2007; Saunders and Steffen 2011; Chava 2014). With respect to loan characteristics, spreads tend to be lower for large loans, short-term loans, loans with fewer lenders, loans with high-performance pricing, revolvers, and unsecured loans.[15] Larger firms and firms with higher credit ratings borrow with lower spreads. Loan spreads decrease with profitability (*ROA*) and *Tobin's Q*, but they increase with *Leverage*.

### 4.2 Robustness Tests of Main Results

In Table 3, we perform a series of additional tests to ascertain the robustness of our baseline results. In panel A, we investigate whether the loan cost advantage of transitional

[13] Our sample includes 9,894 loan packages, with a mean package-level loan spread of 150 bp.

[14] Using SIC codes, we define as "grey industries" the sectors 371 (Motor Vehicles and Motor Vehicle Equipment), 375 (Motorcycles, Bicycles, and Parts), 421 (Trucking and Courier Services, except Air), as well as 131 and 132 (Natural Gas Liquids, Crude Petroleum, Natural Gas).

[15] The finding that unsecured loans have lower spreads seems surprising at first glance. However, according to Strahan (1999), larger borrowers and borrowers with highly rated debt pay lower interest rates and are more likely to be able to borrow on an unsecured basis relative to smaller and less well-rated borrowers. Hence, he finds that loans that are secured carry higher interest rates. Our results are consistent with his findings.

**Table 3** Transitional revenue and syndicated loan spreads: robustness analysis. Note: this table reports regressions at the loan-facility level relating transitional revenue (*Transitional Rev*) to syndicated loan spreads (*Loan Spread*). Panel A reports regressions using the average of *Transitional Rev* in the previous three (*Transitional Rev 3y*) and five years (*Transitional Rev 5y*) before the initiation of a syndicated loan, respectively. Panel B reports regressions for EU and non-EU borrowing firms, respectively. Panel C reports regressions for US and non-US borrowing firms, respectively. We control for other loan and firm characteristics as in Table 2. Variable definitions are reported in Appendix 1. Standard errors, reported in parentheses, are clustered at the borrower level

| Dependent variable | Panel A: Long-term effect of transitional revenue | | Panel B: EU and non-EU countries | | Panel C: US and non-US countries | |
|---|---|---|---|---|---|---|
| | $Loan\ Spread_{i,j,c,t}$ | | $Loan\ Spread_{i,j,c,t}$ | | $Loan\ Spread_{i,j,c,t}$ | |
| | Full sample | Full sample | EU | Non-EU | US | Non-US |
| | (1) | (2) | (1) | (2) | (1) | (2) |
| $Transitional\ Rev\ 3y_{j,c,t-1}$ | −14.213*** | | | | | |
| | (4.034) | | | | | |
| $Transitional\ Rev\ 5y_{j,c,t-1}$ | | −14.432*** | | | | |
| | | (4.052) | | | | |
| $Transitional\ Rev_{j,c,t-1}$ | | | −21.741** | −11.962*** | −17.806*** | −11.165* |
| | | | (9.443) | (4.222) | (4.448) | (5.937) |
| Controls | Yes | Yes | Yes | Yes | Yes | Yes |
| Loan purpose fixed effects | Yes | Yes | Yes | Yes | Yes | Yes |
| Year fixed effects | Yes | Yes | Yes | Yes | Yes | Yes |
| Country fixed effects | Yes | Yes | Yes | Yes | Yes | Yes |
| # Obs. | 14,428 | 14,428 | 2,361 | 12,064 | 7,504 | 6,919 |
| Adj. $R^2$ | 0.505 | 0.505 | 0.539 | 0.514 | 0.565 | 0.480 |

*, **, and *** indicate statistical significance at 10%, 5%, and 1%, respectively

revenues originates from transient or long-lasting effects. Our baseline regressions use the transitional revenue one year before the loan initiation date. However, these revenues might be driven by one-time shocks, while banks instead may focus on longer-term trends reflecting more fundamental green activities when deciding on loans, such as the firm's transitional revenues over the past three or five years. Thus, for robustness, we use the yearly average of a firm's transitional revenue over a three- or five-year window prior to loan initiation. The estimated coefficients on *Transitional Rev 3y* and *Transitional Rev 5y* are negative and significant, which supports a long-lasting effect of transitional revenue on a firm's borrowing cost.

In panel B, we separate the sample into borrowers from EU and non-EU countries (we use the year 2020 to classify firms). While the estimated effects are larger among EU borrowers, we continue to observe a significant effect also among non-EU firms. A one-standard-deviation increase of *Transitional Rev* is associated with a 8 bp decline of loan spreads in EU countries, and a 4 bp decline in non-EU countries, respectively (using the subsample standard deviations).

Finally, in panel C, we address concerns about potential sample misrepresentation due to the large number of US firms in the estimation. However, we find a significant and negative effect of transitional revenue for both US and non-US borrowers.

### 4.3 Role of ESG Ratings and Climate Change Variables

An interesting question that arises is whether *Transitional Rev* has information content beyond what is contained in ESG ratings or climate-specific risk and opportunity measures that lenders should have access to when pricing loans. Specifically, if, for example, ESG rating agencies comprehensively address ESG performance in their methodologies, the effect of Taxonomy-eligible revenue shares may be absorbed, or significantly reduced, when controlling for ESG ratings. To explore this possibility, we estimate in Table 4, panel A, variants of Eq. 1 which explicitly control for ESG ratings (*ESG Rating MSCI* in column 1 and *ESG Rating Asset4* in column 2). The estimates show that *Transitional Rev* remains negatively and significantly related to loan spreads, with the magnitude of the effect changing only little compared to Table 2. For MSCI's ratings, we find that borrowers with better ESG performance pay lower interest rates. Overall, these results indicate that the classification in the Taxonomy does not overlap much with what ESG ratings capture, thereby containing complementary information.

In Table 4, panel B, we conduct a similar exercise but replace the ESG ratings with two alternatives that reflect a borrower's exposure to climate transition risk. Borrowers may deploy green investments to reduce carbon emissions, implying that the cost effects we observe may be driven in part by a borrower's emission status. To account for this possibility, we add in columns 3 and 4 Scope 1 and Scope 2/3 emissions to the estimation. In both columns, we continue to find a strong negative coefficient on *Transitional Rev*. In line with evidence on a carbon risk premium in equity markets (Bolton and Kacperczyk 2021), we observe a positive effect of Scope 1 emissions on loan spreads.

In Table 4, panel C, we replace carbon emissions with measures that more reflect a borrower's overall exposure to climate change. We capture such exposure by controlling for Sautner et al. (2023)'s measure of climate change opportunities ($CCExposure^{Opp}$) as well as their corresponding measures for exposures to physical and regulatory climate shocks ($CCExposure^{Phy}$ and $CCExposure^{Reg}$). A benefit of the measures is that they are broad and capture both upside (opportunities) and downside (physical and regulatory shocks) aspects. They thereby relate to the Taxonomy's climate focus and its idea to capture also positive contributions. When controlling for these variables, we can gauge whether *Transitional Rev* is so broad that it captures all activities related to any exposure to climate change. The estimates in columns 5 and 6 demonstrate that *Transitional Rev* does not simply reflect broad exposure to climate change (neither the opportunities nor risk dimensions): the variable remains negatively and significantly related to loan spreads. Hence, there is information content in the Taxonomy classification beyond a borrower's broad exposure to climate change. The estimates further show that spreads are lower for borrowers with larger exposure to climate opportunities.

### 4.4 Non-Pricing Loan Terms

Qian and Strahan (2007) contend that while higher interest rates are an effective tool to price asymmetric information, higher rates may have adverse effects by worsening the moral hazard problem of borrowers (they may select riskier projects). Lenders may address this risk by imposing restrictive debt terms, causing borrowers to forgo profitable but risky investment opportunities. An implication is that non-pricing terms could be complements to loan spreads.

**Table 4** Transitional revenue and syndicated loan spreads: ESG ratings and climate change exposure. Note: this table reports regressions at the loan-facility level relating transitional revenue (*Transitional Rev*) to syndicated loan spreads (*Loan Spread*). Panel A reports regressions after controlling for ESG ratings by MSCI (*ESG Rating MSCI*) and Asset4 (*ESG Rating Asset4*), respectively. Panel B reports regressions after controlling for direct and indirect carbon emissions. Panel C reports regressions after controlling for the firm-level measures of climate change exposure from Sautner et al. (2023) ($CCExposure^{Opp}$, $CCExposure^{Phy}$, and $CCExposure^{Reg}$). We control for other loan and firm characteristics as in Table 2. Variable definitions are reported in Appendix 1. Standard errors, reported in parentheses, are clustered at the borrower level

| | Panel A: Controlling for ESG scores | | Panel B: Controlling for carbon emissions | | Panel C: Controlling for climate change exposure | |
|---|---|---|---|---|---|---|
| Dependent variable | $Loan\ Spread_{i,j,c,t}$ | | $Loan\ Spread_{i,j,c,t}$ | | $Loan\ Spread_{i,j,c,t}$ | |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| $Transitional\ Rev_{j,c,t-1}$ | −18.251*** | −17.698*** | −12.196*** | −10.932*** | −21.547*** | −21.605*** |
| | (4.330) | (4.820) | (4.000) | (4.034) | (4.344) | (4.343) |
| $ESG\ Rating\ MSCI_{j,c,t-1}$ | −4.144*** | | | | | |
| | (1.078) | | | | | |
| $ESG\ Rating\ Asset4_{j,c,t-1}$ | | −0.076 | | | | |
| | | (0.081) | | | | |
| $Log\ Scope\ 1\ Emissions_{j,c,t-1}$ | | | 2.262*** | | | |
| | | | (0.535) | | | |
| $Log\ Scope\ 2/3\ Emissions_{j,c,t-1}$ | | | | 1.202 | | |
| | | | | (0.777) | | |
| $CCExposure^{Opp}{}_{j,c,t-1}$ | | | | | −3.285*** | −3.668*** |
| | | | | | (0.919) | (0.971) |
| $CCExposure^{Phy}{}_{j,c,t-1}$ | | | | | | 2.665 |
| | | | | | | (8.186) |
| $CCExposure^{Reg}{}_{j,c,t-1}$ | | | | | | 4.369 |
| | | | | | | (4.023) |
| Controls | Yes | Yes | Yes | Yes | Yes | Yes |
| Loan purpose fixed effects | Yes | Yes | Yes | Yes | Yes | Yes |
| Year fixed effects | Yes | Yes | Yes | Yes | Yes | Yes |
| Country fixed effects | Yes | Yes | Yes | Yes | Yes | Yes |
| # Obs. | 9,048 | 11,052 | 12,912 | 12,912 | 10,937 | 10,937 |
| Adj. $R^2$ | 0.500 | 0.505 | 0.510 | 0.508 | 0.531 | 0.532 |

*, **, and *** indicate statistical significance at 10%, 5%, and 1%, respectively

In Table 5, we re-estimate Eq. 1 and replace *Loan Spread* with a series of non-pricing terms. In columns 1 and 2, we find no significant associations between *Transitional Rev* and loan covenants or maturity. This suggests that lenders impose similar loan terms on borrowers with high or low transitional revenue. Instead, column 3 shows a negative and statistically significant relation between *Transitional Rev* and *Secure*, suggesting that loans given to climate resilient borrowers are less likely to be collateralized. In column 4, *Transitional Rev* is negatively and significantly associated with *Loan Amount*. Hence, lenders provide smaller loans to borrowers with a high level of transitional activities. A one-standard-deviation increase in *Transitional Rev* is associated with a 6.4% decline in the loan amount. This effect highlights the importance of controlling for loan size in the baseline estimation.

**Table 5** Transitional revenue and loan contracting characteristics. Note: this table reports regressions at the loan-facility level relating transitional revenue (*Transitional Rev*) to the number of loan covenants (*Loan Covenants*), the raw loan term (*Loan Maturity*), whether the loan is collateralized (*Secure*), and the raw loan amount in US$ millions (*Loan Amount*). We control for other loan and firm characteristics as in Table 2 (excluding, as control variable, the dependent variable in each regression). Variable definitions are reported in Appendix 1. Standard errors, reported in parentheses, are clustered at the borrower level

| Dependent variable | $Loan\ Covenants_{i,j,c,t}$ | $Loan\ Maturity_{i,j,c,t}$ | $Secure_{i,j,c,t}$ | $Loan\ Amount_{i,j,c,t}$ |
|---|---|---|---|---|
| | Full sample | Full sample | Full sample | Full sample |
| | (1) | (2) | (3) | (4) |
| $Transitional\ Rev_{j,c,t-1}$ | 0.061 | 1.132 | −0.082*** | −145.724*** |
| | (0.049) | (1.345) | (0.019) | (44.627) |
| Controls | Yes | Yes | Yes | Yes |
| Loan purpose fixed effects | Yes | Yes | Yes | Yes |
| Year fixed effects | Yes | Yes | Yes | Yes |
| Country fixed effects | Yes | Yes | Yes | Yes |
| # Obs. | 14,709 | 14,709 | 14,709 | 14,709 |
| Adj. $R^2$ | 0.338 | 0.254 | 0.325 | 0.238 |

*, **, and *** indicate statistical significance at 10%, 5%, and 1%, respectively

## 5 Economic Mechanisms

### 5.1 Risk Management Channel: Regulatory and Physical Climate Risks

The prior section shows that banks charge lower interest rates on loans issued to firms with higher revenues from activities linked to the Taxonomy. In this section, we perform a series of tests to explore the underlying mechanisms.

We start by exploring a risk management channel. Firms are exposed to regulatory and physical climate risks, and both risks have increased substantially over the past decades. Regarding regulatory climate risks, over 80% of high to middle-income countries have introduced policies that support renewables directly, such as feed-in tariffs and power purchase agreements (IRENA 2018). Moreover, climate-related regulations, such as carbon taxes or cap-and-trade policies, are imposed increasingly across countries to price the climate externalities of carbon emissions. Krueger et al. (2020) document that institutional investors widely believe that regulatory climate risks have begun to materialize, and Ilhan et al. (2021) provide evidence consistent with this from the options market.

To understand the role of climate regulatory risk as a driver behind the negative relationship between *Transitional Rev* and *Loan Spread*, we analyze how this relationship varies based on a country's environmental policy stringency. The value of green activities should be particularly large in countries where climate regulation targets brown activities. In other words, if transitional revenue indeed reflects activities that contribute to climate change mitigation, then it should be most valuable in reducing risks in countries with stringent regulation.

We measure this stringency using the OECD EPS index, which provides an internationally comparable measure of the stringency of environmental policy with a broad time and

country coverage.[16] The index covers 28 OECD and 6 non-OECD countries for the period from 1990 to 2015. The index has not been updated since 2015, but – considering the usually slow-changing nature of most environmental policies – we follow Cojoianu et al. (2020) and use a country's 2015 index value to fill in the last three years in our sample. Using these data, we partition the sample into two subsamples based on the median value of the index in a year, and re-estimate Eq. 1 within each subset. The results are reported in Table 6, panel A. In column 1, the coefficient on *Transitional Rev* is negative and highly statistically significant among borrowers in countries with stringent environmental policies. In contrast, the effect is much smaller among borrowers in countries with lax environmental policies (column 2). This suggests that banks value climate resilience more under the fear of climate-related regulatory cost; this corroborates that the effect of transitional revenue operates through a risk channel.

Transitional activities may be particularly valuable in countries with high physical climate risk exposures. Transitional activities may not directly affect a firm's exposure to extreme weather, storms, or draughts, but banks may perceive them as particularly valuable in countries with high physical climate risks. Moreover, a country with high physical risks may face more public pressure to raise the regulatory costs on polluting activities and to reward green activities. Consequently, one should also expect stronger pricing effects of transitional revenues among firms located in countries most vulnerable to physical climate risk. To test this prediction, in Table 6, panel B, we partition the sample into two subgroups based on the median value of the country-level climate change vulnerability index from Closset et al. (2018). When we re-estimate Eq. 1 within each subset, the coefficient estimate of *Transitional Rev* is more than twice as large among borrowers in countries most vulnerable to climate change. This result is consistent with Painter (2020)'s evidence on municipal bonds, which suggests that investors demand a higher rate of return when holding bonds of counties with higher sea level rise risk.

### 5.2 Risk Management Channel: Effects of Carbon Taxes

Carbon taxes are the main policy tool through which carbon emission reductions can be achieved (Stroebel and Wurgler 2021), and they therefore constitute one way through which regulatory risks materialize. As carbon taxes increase the cost of firms' carbon emissions, they increase climate-related risks at brown firms relative to those at green firms. Carbon taxes also provide incentives for green innovation, which should benefit firms with large transitional activities. To examine the effects of carbon taxes, we test how the relationship between *Transitional Rev* and loan spreads varies around the introduction of a carbon tax.

[16] The EPS index is constructed through two steps: (i) selecting and scoring individual policy instruments, and (ii) aggregating this information. Individual policy instruments primarily related to climate and environment are selected and scored between 0 and 6 to reflect the relative stringency across countries of a particular policy instrument. Next, the instrument-specific indicators are aggregated into five policy categories: taxes, trading schemes, feed-in tariff schemes, emission standards, and government R&D subsidies. The methodology behind the index construction can be found in Botta and Koźluk (2014).

**Table 6** Transitional revenue and loan spreads: role of climate risks. Note: Panel A reports regressions at the loan-facility level relating transitional revenue (*Transitional Rev*) to loan spreads (*Loan Spread*) depending on a country's environmental policy stringency (EPS). EPS is measured using an index from the OECD statistics database. We split the sample into two subsamples based on the median values of the index in a given year. The sample is limited to countries covered in this database. Panel B reports regressions at the loan-facility level relating transitional revenue (*Transitional Rev*) to syndicated loan spreads (*Loan Spread*) depending on a measure of a country's physical climate risk. We partition the sample based on the sample median of the country-level climate change vulnerability index from Closset et al. (2018) in a given year. In both tables, we control for other loan and firm characteristics as in Table 2. At the bottom of each table, we report the $Chi^2$ test-statistic for a test of the differences of the coefficient estimates of *Transitional Rev* across the two subsamples. Variable definitions are reported in Appendix 1. Standard errors, reported in parentheses, are clustered at the borrower level

| Dependent variable | $Loan\ Spread_{i,j,c,t}$ (1) | $Loan\ Spread_{i,j,c,t}$ (2) |
|---|---|---|
| Panel A: Regulatory climate risks | | |
| | High environmental policy stringency | Low environmental policy stringency |
| $Transitional\ Rev_{j,c,t-1}$ | −33.399*** | −11.035** |
| | (7.876) | (5.107) |
| Controls | Yes | Yes |
| Loan purpose fixed effects | Yes | Yes |
| Year fixed effects | Yes | Yes |
| Country fixed effects | Yes | Yes |
| # Obs. | 2,694 | 7,860 |
| Adj. $R^2$ | 0.524 | 0.562 |
| $Chi^2$ test statistic (*p*-value) | 6.99*** | |
| | (0.0082) | |
| Panel B: Physical climate risks | | |
| | High climate change vulnerability | Low climate change vulnerability |
| $Transitional\ Rev_{j,c,t-1}$ | −20.034*** | −9.111 |
| | (4.767) | (7.184) |
| Controls | Yes | Yes |
| Loan purpose fixed effects | Yes | Yes |
| Year fixed effects | Yes | Yes |
| Country fixed effects | Yes | Yes |
| # Obs. | 8,841 | 4,362 |
| Adj. $R^2$ | 0.552 | 0.500 |
| $Chi^2$ test statistic (*p*-value) | 3.01* | |
| | (0.0830) | |

*, **, and *** indicate statistical significance at 10%, 5%, and 1%, respectively

The treatment sample consists of firms in tax adopting countries, while the control sample comprises firms in non-adopting countries in the same world region.[17]

[17] IA Table 2 lists the countries in the sample that adopted carbon tax regimes before and during our estimation period. We collect data on carbon taxes from the Tax Foundation and multiple internet sources. We consider the following regions: Asia (including Australia), Europe, and South America. North America is not included in this analysis because no countries in this region adopted a carbon tax regime during our sample period.

Before estimating the results, IA Fig. 1 compares the evolution of *Transitional Rev* between treated and control firms from five years before to five years after a carbon tax adoption. While the level of *Transitional Rev* in the treatment group hovers above that of the control sample in the entire event window, the increase in *Transitional Rev* in the treatment group is considerably greater than in the counterfactual group after a carbon tax adoption. Hence, carbon taxes are associated with a persistent rise in *Transitional Rev* in treated firms.

We estimate the differential impact of carbon taxes on the relation between *Transitional Rev* and *Loan Spread* over a two-sided five-year window around a country's carbon tax introduction (i.e., we include eleven years in total):[18]

$$\begin{gathered} Loan\ Spread_{i,j,c,t} = \alpha + \beta_1\ Treat_c\ \times\ Post_{c,t} \times Transitional \\ Rev_{j,c,t-1} + \beta_2\ Transitional\ Rev_{j,c,t-1} \times Treat_c + \beta_3\ Transitional\ Rev_{j,c,t-1} \\ \times\ Post_{c,t}\ +\ \beta_4\ Treat_c\ \times\ Post_{c,t} + \beta_5\ Transitional\ Rev_{j,c,t-1} + \beta_6\ Treat_c + \\ \beta_7\ Post_{c,t}\ +\ \delta'\ \boldsymbol{X}_{i,j,c,t} + \mu_j + \theta_t + \gamma_c + \varepsilon_{i,j,c,t} \end{gathered} \tag{2}$$

where $Loan\ Spread_{i,j,c,t}$ is the interest rate spread on loan facility $i$ from firm $j$ in country $c$, year $t$. *Treat* equals one when a borrower is from a country that introduced a carbon tax, and zero otherwise. $Post_{c,t}$ equals one for observations after the introduction of a carbon tax, and zero otherwise. We include loan purpose, year, and industry fixed effects, respectively. The coefficient of interest is $\beta_1$, which reflects the differential effect of transitional revenue on loan spreads between treated and control groups following the introduction of a carbon tax.

Table 7 displays the regression results. In column 1, *Treat* × *Post* × *Transitional Rev* is negative and statistically significant, suggesting that higher transitional revenue is associated with larger loan cost reductions after the implementation of a carbon tax.[19] Compared with control firms with no carbon tax, a one-standard deviation increase in *Transitional Rev* is associated with a 28 bp larger loan spread reduction at treated firms around the tax adoption.

If transitional revenue reduces loan cost by reducing climate-related risk, we expect to see stronger effects among firms with generally higher base-level credit risk. To verify this conjecture, columns 2 and 3 partition the sample into two groups based on whether treated firms are rated below or above BBB by S&P. In column 2, among firms rated below BBB, *Treat* × *Post* × *Transitional Rev* increases in size and remains statistically significant, while, in column 3, the effect is statistically insignificant. Hence, the introduction of a carbon tax lessens the loan financing costs at green firms, particularly if they have higher credit risk.

### 5.3 Green Preferences Channel

Kacperczyk and Peydro (2022) show that banks that make public commitments to carbon neutrality reduce credit supply (in part) because of their green preferences. Motivated by this evidence, we examine whether the loan cost advantage of *Transitional Rev* varies across banks

[18] IA Table 3 presents a balance test that compares mean values of various observables between treatment and control firms in the year in which a carbon tax is introduced. Consistent with IA Fig. 1, the mean values of *Loan Spread* and *Transitional Rev* among treated firms are higher, though the differences are not statistically significant. Loan characteristics are mostly statistically different between the two groups, whereas firm characteristics are similar. This comparison prompts us to control for loan and firm characteristics.

[19] The magnitude and statistical significance of the effect remain unchanged when we use a two-sided three-year event window.

**Table 7** Transitional revenue and loan spreads: role of carbon taxes. Note: this table reports regressions at the loan-facility level relating transitional revenue (*Transitional Rev*) to syndicated loan spreads (*Loan Spread*) before and after the introduction of a carbon tax in a country. *Loan spread* is the loan spread on the loan facility *i* of borrowing firm *j* located in country c in year *t*. *Treat* equals one for firms located in countries adopting a carbon tax, and zero otherwise. *Post* equals one after the adoption of a carbon tax regime in the treated country, and zero otherwise. We control for other loan and firm characteristics as in Table 2. Variable definitions are reported in Appendix 1. Standard errors, reported in parentheses, are clustered at the borrower level

| Dependent variable | $Loan\ Spread_{i,j,c,t}$ Full sample | $Loan\ Spread_{i,j,c,t}$ Credit rating < BBB | $Loan\ Spread_{i,j,c,t}$ Credit rating ≥ BBB |
|---|---|---|---|
| | (1) | (2) | (3) |
| $Treat_c \times Post_{c,t} \times Transitional\ Rev_{j,c,t-1}$ | −71.059** | −100.834*** | 20.322 |
| | (35.342) | (36.278) | (60.865) |
| $Transitional\ Rev_{j,c,t-1} \times Post_{c,t}$ | 28.074 | 23.988 | −26.167 |
| | (19.415) | (20.412) | (16.729) |
| $Treat_c \times Post_{c,t}$ | 37.500*** | 53.876*** | 22.128 |
| | (11.937) | (17.943) | (15.193) |
| $Treat_c \times Transitional\ Rev_{j,c,t-1}$ | 13.023 | 1.794 | 61.309 |
| | (39.452) | (48.853) | (55.985) |
| $Transitional\ Rev_{j,c,t-1}$ | 37.436 | 45.700 | −79.263*** |
| | (31.126) | (33.364) | (29.094) |
| $Post_{c,t}$ | −5.480 | −3.321 | 7.277 |
| | (5.464) | (6.475) | (5.011) |
| $Treat_c$ | −3.419 | 39.377 | −43.158** |
| | (17.420) | (29.490) | (21.611) |
| Controls | Yes | Yes | Yes |
| Loan purpose fixed effects | Yes | Yes | Yes |
| Year fixed effects | Yes | Yes | Yes |
| Industry fixed effects | Yes | Yes | Yes |
| # Obs. | 1,893 | 1,340 | 547 |
| Adj. $R^2$ | 0.659 | 0.711 | 0.742 |

*, **, and *** indicate statistical significance at 10%, 5%, and 1%, respectively

depending on their green preferences. To quantify these preferences, we exploit two widely adopted initiatives, the Equator Principles (EPs) and Principles for Responsible Investment (PRI).[20] We classify loan-facility observations based on whether one or multiple lenders of a syndicated loan complies with the EPs or PRI. We expect that lending banks affiliated with these initiatives demonstrate their green commitments by financing green investments at more favorable terms. (IA Table 4 shows that both initiatives exhibit variations across loans.)

The results in Table 8 lend support to our expectation. In panel A, we divide the sample into loans from EP signatory and non-signatory banks. In column 1 for EP signatories, a one-standard-deviation increase in *Transitional Rev* is associated with a 6.7 bp decline of the all-in-drawn loan spreads. Somewhat differently, in column 2 for loans undertaken by non-EP signatory banks, a one-standard-deviation increase in *Transitional Rev* is

[20] Hoepner et al. (2021) show that PRI signatories are more committed to incorporating ESG issues into their decision-making and ownership practices.

**Table 8** Transitional revenue and loan spreads: Role of green preferences. Note: Panel A reports regressions at the loan-facility level relating transitional revenue *(Transitional Rev)* to loan spreads *(Loan Spread)* depending on whether the lending institutions are signatories of the Equator Principles (EP). We split the sample into two subsamples based on whether at least one lender in the loan facility is a signatory of the EP. Panel B reports regressions at the loan-facility level relating transitional revenue *(Transitional Rev)* to loan spreads *(Loan Spread)* depending on whether at least one lender in the loan facility is a signatory of the United Nations Principles for Responsible Investing (PRI). In both tables, we control for other loan and firm characteristics as in Table 2. At the bottom of each table, we report the $Chi^2$ test-statistic for a test of the differences of the coefficient estimates of *Transitional Rev* across the two subsamples. Variable definitions are reported in Appendix1. Standard errors, reported in parentheses, are clustered at the borrower level

| Dependent variable | $Loan\ Spread_{i,j,c,t}$ (1) | $Loan\ Spread_{i,j,c,t}$ (2) |
|---|---|---|
| Panel A: Signatories of the Equator Principles (EP) | | |
| | EP lenders | Non-EP lenders |
| $Transitional\ Rev_{j,c,t-1}$ | −18.091*** | −10.610* |
| | (4.262) | (5.655) |
| Controls | Yes | Yes |
| Loan purpose fixed effects | Yes | Yes |
| Year fixed effects | Yes | Yes |
| Country fixed effects | Yes | Yes |
| # Obs. | 8,616 | 5,806 |
| Adj. $R^2$ | 0.513 | 0.518 |
| $Chi^2$ test statistic ($p$-value) | 1.12 | |
| | (0.2897) | |
| Panel B: Signatories of the UN PRI | | |
| | PRI lenders | Non-PRI lenders |
| $Transitional\ Rev_{j,c,t-1}$ | -51.451*** | -11.478*** |
| | (13.433) | (3.949) |
| Controls | Yes | Yes |
| Loan purpose fixed effects | Yes | Yes |
| Year fixed effects | Yes | Yes |
| Country fixed effects | Yes | Yes |
| # Obs. | 1,236 | 13,189 |
| Adj. $R^2$ | 0.466 | 0.515 |
| $Chi^2$ test statistic($p$-value) | 6.91*** | |
| | (0.0086) | |

*, **, and *** indicate statistical significance at 10%, 5%, and 1%, respectively

associated with a 4.1 bp decline only. Results become even stronger in panel B where we partition the sample on basis of PRI signatory statuses. A one-standard deviation increase in *Transitional Rev* is associated with a 17.4 bp (4.4 bp) loan spread decline for PRI (non-PRI) signatories. These effects indicate that a nonfinancial channel contributes to explaining the loan cost advantage of firms with transitional revenues.

## 6 Real and Financial Responses to Transitional Revenue

In a final analysis, we ask whether there are real effects of transitional business activities. If there is indeed a risk channel through which our results operate, then we expect to see improvements in environmental outcomes correlated with transitional revenues. We measure such outcomes using two indicators from Refinitiv Asset4. *Emission Reduction* measures a firm's commitment and effectiveness towards reducing environmental emission in the production and operational process. Higher values indicate a stronger commitment and effectiveness towards reducing emission. *Green Innovation* reflects a firm's capacity to reduce the environmental costs and burdens for its customers, thereby creating new market opportunities through new environmental technologies and processes or eco-designed products. Higher values indicate a stronger capability of green innovations. Using regressions at the firm level, we relate these two variables to a firm's transitional revenue.

$$Env\ Outcome_{j,c,t} = \alpha + \beta\ Transitional\ Rev_{j,c,t-1} + \delta'\ \boldsymbol{X}_{j,c,t-1} + \mu_j + \theta_t + \gamma_c + \varepsilon_{j,c,t}, \quad (3)$$

where $Env\ Outcome_{j,c,t}$ is either *Emission Reduction* or *Green Innovation* of firm *j* in year *t* and $Transitional\ Rev_{j,c,t-1}$ is firm *j*'s revenue share from Taxonomy-eligible transitional activities in year *t-1*. The coefficient of interest is $\beta$, which measures the effect of transitional revenues on environmental outcomes. $\boldsymbol{X}_{j,c,t-1}$ includes a series of controls at the firm level (*Log Assets*, *ROA*, *Leverage*, *Tangibility*, *Tobin's Q*). We saturate the model with industry, year, and country fixed effects. Standard errors are clustered at the borrower level.

Results are reported in Table 9. In column 1, *Transitional Rev* is positively and significantly correlated with a firm's future emission reduction. A one-standard-deviation increase in *Transitional Rev* is associated with a 1.8% increase in the emission reduction score. In column 2, these results extend to environmental innovations, where a one-standard-deviation increase of transitional revenue is associated with a 2.5% increase in the green innovations score. Our tests cannot eliminate the concern over the endogenous relationship between a firm's corporate environmental policies and its transitional economic activities. Yet, the significant correlations between the two factors provide suggestive evidence for the existence of a real climate risk mitigation effect of a firm's transitional economic activities.

**Table 9** Transitional revenue and environmental performance. Note: this table reports regressions at the firm level relating transitional revenue (*Transitional Rev*) to the borrowing firm's future environmental performance. Future environmental performance is proxied by whether a firm reduces its carbon emissions (*Emission Reduction*) or adopts environment-related innovations (*Green Innovation*). We control for firm characteristics as in Table 2. Variable definitions are reported in Appendix 1. Standard errors, reported in parentheses, are clustered at the borrower level

| Dependent variable | $Emission\ Reduction_{j,c,t}$ | $Green\ Innovation_{j,c,t}$ |
|---|---|---|
| | Full sample | Full sample |
| | (1) | (2) |
| $Transitional\ Rev_{j,c,t-1}$ | 0.025** | 0.033*** |
| | (0.010) | (0.010) |
| Controls | Yes | Yes |
| Industry fixed effects | Yes | Yes |
| Year fixed effects | Yes | Yes |
| Country fixed effects | Yes | Yes |
| # Obs. | 30,408 | 30,408 |
| Adj. $R^2$ | 0.294 | 0.149 |

*, **, and *** indicate statistical significance at 10%, 5%, and 1%, respectively

## 7 Conclusion

In this paper, we provide evidence on the potential financial market effects of the EU Taxonomy. Using international data from the syndicated loan market, we demonstrate that, in the past, firms with larger revenue shares of Taxonomy-eligible transitional activities paid lower interest rates. Transitional activities have to make a substantial direct contribution to climate change mitigation. Economically, a one-standard-deviation increase in firm revenue from transitional activities is associated with five basis points lower loan spreads. Effects are more pronounced for firms in countries with greater regulatory and physical climate risk exposure, and when lending institutions have green preferences.

## Appendix 1

Variable definitions

| Variable | Definition |
|---|---|
| *Loan Spread* | Annual interest rate spread paid over LIBOR plus upfront fee for each dollar drawn down from the loan. We remove observations with missing values and trim the variable at 1% and 99%. |
| *Package Loan Spread* | Mean spread across all facilities of a loan package of a borrower. We remove observations with missing values. |
| *Transitional Rev* | Ratio of revenue associated with transitional activities over the total revenue of a firm in a fiscal year. The transitional activities are defined by the EU Taxonomy (2020). |
| *Enabling Rev* | Ratio of revenue associated with enabling activities over the total revenue of a firm in a fiscal year. The enabling activities are defined by the EU Taxonomy (2020). |
| *ESG Rating MSCI* | Aggregate ESG rating score from MSCI IVA. A higher score indicates better ESG performance. |
| *ESG Rating Asset4* | Aggregate ESG rating score from Refinitiv's Asset4. A higher score indicates better ESG performance. |
| *Log Scope 1 Emissions* | Logarithm of the carbon emissions (scope 1) from a firm's own business activities. |
| *Log Scope 2/3 Emissions* | Logarithm of the carbon emissions (the sum of scope 2 & scope 3) from the purchase of electricity, steam, heat or cooling and from direct suppliers. |
| $CCExposure^{Opp}$ | Firm-level measure of exposure to climate change opportunities computed by Sautner et al. (2023). |
| $CCExposure^{Phy}$ | Firm-level measure of exposure to physical climate change shocks computed by Sautner et al. (2023). |
| $CCExposure^{Reg}$ | Firm-level measure of exposure to regulatory climate change shocks computed by Sautner et al. (2023). |
| *Log Loan Amount* | Logarithm of the total amount of a loan facility. |
| *Log Loan Maturity* | Logarithm of the loan maturity in term of months. |
| *Loan Covenants* | Number of covenants of a loan facility. |
| *Log # Lenders* | Logarithm of the number of lenders who participated in a syndicated loan. |
| *Performance Pricing* | Indicator that equals one if there is at least one performance pricing metric for a syndicated loan facility, and zero otherwise. |

| Variable | Definition |
|---|---|
| *Guarantor* | Indicator that equals one if there is a guarantor in a syndicated loan, and zero otherwise. |
| *Revolver* | Indicator that equals one when a loan facility is a revolver, and zero otherwise. |
| *Inst Tranche* | Indicator that equals one when a loan facility includes an institutional tranche (term B or lower), and zero otherwise. |
| *Secure* | Indicator that equals one when a loan facility is secured, and zero otherwise. |
| *SP Rating* | Indicator that equals one when the borrower of a loan facility is rated by S&P, and zero otherwise. |
| *Log Assets* | Logarithm of the total assets of a syndicated loan's borrower. |
| *ROA* | Return on assets of a syndicated loan's borrower. |
| *Leverage* | Ratio of total debt over total assets of a borrower in a loan facility. |
| *Tangibility* | Property, plant, and equipment over total assets of a borrower in a loan facility. |
| *Tobin's Q* | Market value of equity plus book value of debt, scaled by total assets. |
| *Emission Reduction* | Environmental emission index from Asset4. It measures a firm's commitment and effectiveness towards reducing environmental emission in the production and operational process. A higher value of environmental emission reduction indicates a stronger commitment and effectiveness towards reducing environmental emission. |
| *Green Innovation* | Environmental innovation index from Asset4. It reflects a firm's capacity to reduce the environmental costs and burdens for its customers, thereby creating new market opportunities through new environmental technologies and processes or eco-designed products. A higher value of environmental innovation indicates a stronger capability of environmental innovations. |

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**Competing Interest** Zacharias Sautner is on the sustainability council of Lampe Asset Management and Regular Research Visitor at the European Central Bank. He believes this does not constitute a conflict of interest for this article.

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