

One Earth, Volume 4

Supplemental information

The Anthropocene reality of financial risk

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Supplemental Experimental Procedures

The Anthropocene reality of financial risk

Datasets generated during this study are deposited at <https://doi.org/10.7910/DVN/7RY1T9>, but there are restrictions to the availability of the Eikon Refinitiv data as this was obtained under paid license.

Comparison of deforestation risk and environmental ESG scores

We compared environmental ESG scores (Refinitiv Eikon) with deforestation risk scores from the Forest 500 annual review. Companies in the F500 database were matched to company data in Eikon via ISIN codes. Of the 350 companies reviewed by Forest 500, Eikon only provided ESG data for 143 companies.

Forest 500¹ annually rank the 350 companies that have the greatest influence within global forest risk commodity (FRC) supply chains using a detailed scoring methodology.²

For our analysis we used the ‘total score’ from the Forest 500 database. This score represents an assessment of a company’s overall approach to deal with deforestation risk, as well as an aggregate score for all commodities in which the company is trading (averaged across all commodities). We refer to it here as ‘Deforestation risk score’. A low score indicates that a company is not taking meaningful action to deal with deforestation despite dealing with commodities with known deforestation risks.

From Refinitiv Eikon we extracted the total ESG score, as well as the isolated environmental pillar score. The total ESG score is an aggregate score for the environmental, social, and governance metrics used by Eikon to assess companies. The environmental pillar score represents the environmental part of the total ESG score given to a company and is composed of a weighted sum of scores assigned to companies based on disclosed information for the categories “Emission”, “Innovation” and “Resource Use”. These categories are used by Refinitiv Eikon as proxies to capture a company's impact on living and non-living natural systems. Box S1 lists the environmental pillar categories and variables as they are described in Refinitiv Eikon. Weights are assigned based on the relative importance of each theme to an industry group.

Refinitiv is one of several providers of company ESG ratings, via their tool Eikon that provides access to the Refinitiv Data Platform.³ The Refinitiv Eikon score is merely one of several ESG rankings available on the market. We chose to use Eikon because of their transparency in the variables that go into the ESG scores, and their accessibility via academic licenses. The exact variables used by other ESG providers is difficult to disentangle as the data is proprietary and not freely available for scrutiny.⁴ However, all major ESG providers currently dominating the market (including Sustainalytics, underpinning the Morningstar Sustainability Rating) base their scores on financially material information. As such – even though ESG ratings do differ among raters – our analysis is informative.

‘Total deforestation risk score’ was compared against the Refinitiv Eikon ‘environmental pillar score’ using Spearman rank correlation, yielding a correlation coefficient of 0.42.

Table S1. Computational details

Environmental ESG score vs Deforestation risk score	Spearman rank correlation
Correlation Coefficient	0,42
t-statistic	5,523418
p-value	1,58E-07

Refinitiv Eikon environmental pillar categories and associated variables

1. Emission (Emissions, Waste, Biodiversity*, Environmental management systems*)
2. Innovation (Product innovation, Green revenues/R&D/capex)
3. Resource use (Water, Energy, Sustainable packaging*, Environmental supply chain*)

** variables not included in the quantitative scoring methodology*

Methods and assumptions used in estimating the figures presented in Figure 5.

All values are in US\$. For some investment instruments an upper and lower estimate is included due to inconsistencies across data sources.

Table S2. Summary table showing the corporate investment instruments widely categorized as ‘green’ in the financial sector. These do not include public funding or development funding (sometimes referred to as soft loans). Instruments are categorized under Debt and Equity and for each instrument we provide estimates of total capital allocated during 2019. Details of calculations are elaborated below.

Investment category	Specific instrument	Short description	Data source	Amount allocated in 2019	Notes
Debt	Total ‘green’-labelled bonds	Includes: green bonds, sustainability bonds, sustainability- or KPI-linked bonds	Aggregate estimate based on individual bond types listed below	US\$ 290.5bn – US\$ 320.3bn	Issuers: Non-financial corporates, financial corporates, sovereign states, etc.
Debt	Green bonds	Debt instruments where the raised capital (‘proceeds’) is used to finance or re-finance eligible green projects. Green bonds are aligned with the Green Bond Principles	Climate Bond Initiative ⁵ ; BloombergNews ⁶	Issuance: US\$ 247.7bn ⁵ – US\$ 269.2bn ⁶	At least 95% of the proceeds should be dedicated to green projects that are aligned with the Climate Bonds Taxonomy to be included in CBI’s green bond database ⁵
Debt	Sustainability bonds	Bonds where the proceeds are used to finance or re-finance projects that have both social and environmental benefits. Sustainability bonds need to be compliant with the Sustainability Bond Guidelines	BloombergNews ⁶ ; BloombergNEF ⁷	Issuance: US\$ 37.7bn ⁶ – US\$ 46bn ⁷	Sustainability bonds are distinguished from Green bonds because less than 95% of the proceeds go to green projects. Even though we cannot estimate the value of the green component we include it in our overall estimates
Debt	Sustainability- or KPI-linked bonds	Bonds whose coupons vary depending on the achievement by the issuer on environmental, social or governance (ESG)-related KPIs (Key Performance Indicator). An element of accountability is introduced by tracking the issuer’s performance against specific KPIs ⁸	BloombergNews ⁶	Issuance: US\$ 5.1bn ⁶	Contrary to green and sustainability bond, sustainability/KPI-linked bond coupons vary according to the achievement of specific KPIs, there is no commitment by the investee that the use of proceeds will be allocated specifically towards projects with

					environmental benefits. Sustainability-linked bonds were only introduced in the last half of 2019 ⁷
Debt	Transition bonds	Proceeds from this new class of bonds are intended to exclusively finance firms' transition projects toward reduced environmental impact. Although the issuer or the project do not have to be categorized as 'green', the raised capital must be used for environmental transition-related activities. ⁹ Transition bonds have relatively short maturities and are tied to clear targets	Climate Bond Initiative ¹⁰		CBI (2020) ¹⁰ provides an example of a bond labelled as "transition bond", which according to them should not be labelled as a transition bond. Given their currently authoritative voice on green/transition bonds, and lack of an established definition, we choose not to estimate this instrument type
Debt	Total 'green' loans	Includes green, syndicated, sustainability-linked loans and investment loans	Aggregate estimate based on individual loan types listed below	US\$ 133.3bn – US\$ 235.8bn	
Debt	Green loans	Loans issued based on the Green Loan Principles (GLP) where a dedicated use of proceeds to finance green projects is mandated. Green loans usually have lower borrowing costs compared to traditional loans (i.e. a lower cost of capital)	Climate Bond Initiative ⁵ ; BloombergNews ⁶	US\$ 10bn⁵ – US\$ 94bn⁶	Green loans are often syndicated (i.e. provided by a group of lenders). Syndicated loans are often larger. Deutz et al. ¹¹ estimate green loans at US\$ 89.6bn. Their estimate includes syndicated green loans. While Bloomberg does not provide information on what loans are included, it is likely that they too include syndicated loans. This would explain the difference in value between those reported by CBI ⁵ and BloombergNews ⁶ (and Deutz et al. ¹¹)
Debt	Sustainability-linked loans	Loans provided by lenders in return for sustainability commitments made by the private borrowers, and agreed	Deutz et al. ¹¹ ; BloombergNews ⁶	US\$ 121.5bn¹¹ – US\$ 140bn⁶	Classification of a sustainability-linked loan does not depend on how the proceeds are used – the

		between borrowers and lenders. Sustainability performance targets such as key performance indicators, external ratings and/or equivalent metrics are used to track the borrower's sustainability performance against the agreed commitments ¹²			defining feature is that pricing is tied to the borrower's performance against certain pre-determined sustainability criteria. ¹³ Sustainability Linked Loan Principles (SLLP) were first published in March 2019
Debt	ESG-compliant collateralized loan obligations	A Collateralized Loan Obligation (CLO) is a type of special purpose vehicle that reduces the lender's risk of extending credit. The loan is divided into tranches, which are sold to interested parties (e.g. investors) as a form of security. Owners of different tranches are exposed to different associated levels of risk and entitlement to payments. In case of a loan default, the lender is not at risk of losing money	S&P ¹⁴	US\$1.8bn ¹⁴	ESG-compliant CLOs were first launched in 2018. Value was reported in EUR, and converted to USD with the rate 1 EUR = 1.2 USD (March 11, 2021) ¹⁵ . The value refers to the EU market from 2018- first half of 2019, as no global estimate was found. There is a risk of loans in this category being counted in the green loans category (above) but the total issued amounts are small in comparison and do not significantly alter the overall estimates
Equity	Total equity	Includes public and private equity funds	Aggregate estimate based on equity data listed below	US\$ 30.954trn	
Equity	Sustainable public equity	Sustainable investing is an investment approach where environmental, social and governance (ESG) factors are considered in portfolio selection and management ¹⁶	Global Sustainable Investment Alliance ¹⁶	US\$ 30.24trn in 2018 ^{16,*}	The value (US\$ 30.24trn) refers to the sustainable investing assets in the five major markets (i.e. it is not a global estimate)
Equity	Green private equity funds	Private equity funds are collective investment schemes used for making	Deutz et al. ¹¹	US\$ 715bn ¹¹	

		(primarily) equity investments according to investment strategies with a specific intent			
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* Note: the Global Sustainable Investment Alliance¹⁶ estimates Sustainable public equity figures in their biannual report. Figures for 2019 are due to come out in April 2021. We have therefore included figures from the 2018 report with the aim of updating these before publication.

Table S3. Summary table showing estimates of the total ‘mainstream’ (i.e. not sustainable/green) capital flows allocated to each category. All values are in US\$, estimated for 2019.

Investment category	Specific instrument	Short description	Data source	Amounts per year (USD)	Notes
Debt	Total Debt Securities	Debt securities are negotiable financial instruments serving as evidence of a debt ¹⁷	Bank of International Settlements ¹⁸	US\$ 119.654 trn	Value refers to (Q4) 2019, see notes below for estimation.
Equity	Total Equity	Includes total private and public equity (listed below)		US\$ 95.12 trn	The total value is US\$ 94.72987 trillion.
Equity	Private Equity, fundraising	Private equity refers to fundraising of global private equity companies or investments into a fund in the form of an equity stake	Preqin ¹⁹	US\$ 729.87bn	This value refers to the aggregate capital raised through equities in private companies
Equity	Public Equity, market capitalization	Market capitalization (also called market value) is the number of shares outstanding for listed domestic companies multiplied by the share price ²⁰	Statista ²¹	US\$ 94.38 trn	This value represents the global domestic equity market capitalization worldwide in 2019

Comparing green and mainstream finance

DEBT: The proportion of estimated global debt that is “green” was calculated by dividing “Total green debt” (Table S2) by “Total Debt Securities” (Table S3), resulting in 0.35% - 0.46%. The range stems from the fact that some debt instruments estimates (in value) were associated with ranges and we therefore calculated a lower total (based on minimum figures) and a higher total (based on maximum range figures).

EQUITY: The proportion of estimated global equity that is “green” was calculated by dividing “Total green equity” (Table S2) by “Total mainstream equity” (reported in Table S3), resulting in 32.5% of assets invested sustainably.

TOTAL CAPITAL INVESTED: Proportion of total global capital invested that is “green” was calculated by summing “Total green debt” and “Total green equity” (Table S2), and dividing by “Total Mainstream” (i.e. the sum of “Total Debt Securities” and “Total Equity”) (reported in Table S3).

Defining green financing

Below we define (in detail) the investment instruments listed in Tables S2 and S3 and outline how the values were calculated, and the assumptions made.

The Financing Climate report¹¹ defines ‘green financial products’ as a collection of financial instruments, primarily debt and equity, that facilitate the flow of investment capital into companies and projects that can channel financing toward green investments that produce environmental benefits.

1. Green Debt:

A. Green bonds

Green bonds are bonds specifically linked to climate-change mitigation and adaptation & resilience (SDGs 6, 7, 9, 11, 13, 14 & 15).²² Green bonds can also finance blue projects.²³ The total market size of green bonds was estimated from Climate Bond Initiative data⁵, which reports an aggregated market size of US\$ 257.7bn (this value refers to both green-labelled bonds and loans), of which US\$ 10bn were green loans (and the rest green bonds). The value corresponding to green loans (US\$ 10bn) was therefore deducted from the total value reported by CBI, resulting in green bond market size corresponding to US\$ 247.7bn for 2019. For a summary on how different green bond database providers define and classify green bonds, see the report published by ICMA.²⁴

B. Sustainability bonds

Sustainability bonds are bonds where companies need to invest a 100% of proceeds in a mixture of green and social activities with a target population and comply with the Sustainability Bond Guidelines. However, some bond database providers (e.g. Bloomberg) do not require any additional reporting on how the use of proceeds was managed for the bond to be included in their reckoning ICMA.²⁴ Thus the values presented might be a high (or over) estimate of the actual market size.

The difference between green and sustainability bonds is that green bonds need to use at least 95% of proceeds for green projects, whereas sustainability bonds proceeds have to be used to finance a mix of green and social projects.

C. Sustainability-, or KPI-linked bonds

Sustainability-, or KPI-linked bonds are an emerging product in which the coupons of general corporate purpose bonds vary depending on the achievement by the issuer ESG-related KPIs. Proponents argue that tracking the issuer’s sustainability performance regarding specific KPIs can contribute to increased accountability.⁸

D. Transition bonds

Proceeds from this new class of bonds are intended to exclusively finance firms’ transition projects toward reduced environmental impact. Although the issuer or project do not have to be categorized as ‘green’, the raised capital must be used for environmental transition related activities.⁹ Consequently, transition bonds may be issued by ‘brown’ firms that aim to use the proceeds for financing operations and technologies that support their ‘green’ transition. Transition bonds have relatively short maturities and are tied to clear targets for decarbonizing businesses. Currently, transition bonds are poorly defined, and a white paper from the Climate Bonds Initiative (Table 6)¹⁰ gives the example of a ‘sustainable

transition'-labelled bond issued by Marfig which does not address sources of emissions and has attracted criticism. Although there are few bonds that have been labelled as transition bonds, it is an instrument that might become popular and there is a debate as to whether they contribute to sustainability financing or not. For examples of this debate, see e.g. Environmental Finance²⁵ and BloombergNews⁶.

E. Green loans

Green loans are based on the Green Loan Principles (GLP) and have a dedicated use of proceeds to finance green project(s). The borrower commits to use the credit (which is borrowed from a bank or a syndicate of lenders) to finance projects with environmental benefits. Green loans have typically lower borrowing costs compared to traditional loans. Both single lenders (e.g. a bank) and syndicates of lenders might offer green loans. In some estimates of the total green loan market size, green syndicated loans are included.¹¹ Although the GLPs provide some guidance on how to define of green loan, different data providers might use additional guidelines (e.g. CBI estimates green loans based on compliance with GLP as well as the Climate Bonds Standard and a number of country specific guidelines)²⁶ to report on the market size of green loans. For example, Gilchrist et al.²⁷ report that organizations such as the International Finance Corporation (IFC) at the World Bank estimate green loans by identifying the projects that incorporated green activities databases on syndicated bank loans. Furthermore, country-specific green lending categories tend to be selected based on national strategic priorities, economically important and high impact sectors, and local sustainability challenges.²⁸ This makes it hard to compare green loans across jurisdictions. The lack of transparency regarding the methods used to estimate the green loan market size (e.g. Bloomberg methods are not accessible) represents a notable challenge to the estimation of the green loan market size. We therefore include both the high (US\$ 94bn) market value estimated by Bloomberg⁶ and the low (US\$ 10 bn) by CBI⁵ for 2019.

F. Sustainability-linked loans

ICMA¹² defines sustainability-linked loans as "loan instruments and/or contingent facilities (such as bonding lines, guarantee lines or letters of credit) which incentivise the borrower's achievement of ambitious, predetermined sustainability performance objectives. The borrower's sustainability performance is measured using sustainability performance targets (SPTs), which include key performance indicators, external ratings and/or equivalent metrics and which measure improvements in the borrower's sustainability profile."

Conceptually, green loans and sustainability-linked loans are two different products. Green loan proceeds are used for green purposes, whereas for sustainability-linked loans there is no commitment by the borrower that the use of proceeds will be allocated specifically towards green projects with environmental benefits. Instead, sustainability-linked loans incentivize the borrower to improve their environmental performance against specific sustainability criteria, because the margin on the loan is adjusted according the borrower's performance.¹³ Sustainability-linked loans provide more flexible financing compared to green loans.²⁹

However, ICMA¹² states that in some instances, a loan may be structured to allow for its categorization as both a green loan, aligned with the GLP, and a sustainability-linked loan. Although our sources (Bloomberg, CBI) distinguish between green and sustainability-linked loans, due to lack of transparency on how they measure green loans, the numbers reported here might include some double-counting.

G. ESG-compliant CLOs

According to S&P Global Market Intelligence¹⁴, in June 2019 the European ESG-compliant CLO market size was EUR 1.5 bn, and the total EU CLO market was approximately EUR 27 bn. ESG-compliant CLOs were launched in 2018, and were expected to grow steadily. A white paper published by SEB et al. in 2018³⁰ stated that the CLOs that focus on the “E” part of ESG, or “green” CLOs have “large growth potential”. However, no global estimate of ESG-compliant CLOs for 2019 was found, possibly due to the recent introduction of this new investment vehicle.

2. Green Equity

H. ESG-related investments via public equity

The 2018 Global Sustainable Investment Review (GSIA)¹⁶ states that the sustainably invested assets in the five major markets (Europe, United States, Canada, Japan, and Australia and New Zealand) was US\$ 30.7 trillion at the start of 2018. According to GSIA¹⁶, sustainable investment encompasses seven activities and strategies, for example negative/exclusionary screening, ESG integration and impact/community investing. To estimate the sustainable public equity, we deducted the impact/community investing value (US\$ 444.26bn) from the total sustainable investing value (US\$ 30.683trn), resulting in US\$ 30.239trn. The reason is that ‘impact/community investing’ is defined as “targeted investments aimed at solving social or environmental problems, and including community investing, where capital is specifically directed to traditionally underserved individuals or communities, as well as financing that is provided to businesses with a clear social or environmental purpose” (pp.7).¹⁶ Given that this category lumps two forms of investing; where the former (i.e. community investments) cannot be compared to other equity investments and the latter is not well defined, our assessment was to remove this category from the total estimate.

I. Green private equity

Private equity funds are collective investment schemes used for making (primarily) equity investments according to investment strategies with a specific intent. It can include equity investments in both private or public companies. No official consolidated data exists for green private equity, but Deutz et. al¹¹ outline a transparent methodology for estimating it. They include impact investing (see definition above) in their green private equity estimate, which is reported here.

Mainstream debt/equity

1. Debt Securities

To estimate total debt, we rely on estimates of debt securities. These are negotiable financial instruments serving as evidence of a debt.¹⁷ According to IMF Handbook on Security Statistics¹⁷ negotiability refers to “the fact that legal ownership of the instrument can be transferred from one owner to another by delivery or endorsement. While any financial instrument can potentially be traded, debt security is a term designed for debt that is traded on an organized exchange or “over the counter” (OTC), although evidence of actual trading is not required. The OTC market involves parties negotiating directly with one another, rather than on a public exchange.” The category ‘debt securities’ therefore does not include private debt. ‘Private debt’ is a term typically applied to debt investments which are not financed by banks and are not issued or traded in an open market.³¹ ‘Private’ refers to the investment instrument itself and not necessarily the borrower (i.e. both public and private companies can borrow via private

debt). Private debt falls into a broader category termed ‘alternative debt’ or ‘alternative credit’, and is used interchangeably with ‘direct lending’, ‘private lending’ and ‘private credit’.³¹

For the estimation of total debt securities, we used data from the Bank of International Settlements statistics (specifically Table C1 “Summary of debt securities outstanding, Q4, 2019”)¹⁸ representing the outstanding value of Total (global) Debt Securities at end of 2019 (Q4). Theoretically, the value for Total Debt Securities (TDS) reported by BIS is the sum of International Debt Securities (IDS) and Domestic Debt Securities (DDS). DDS is reported by national authorities, while IDS are defined by BIS and values reported are computed by BIS from commercial data sources. TDS is reported by some, though not all, nations. Where nations do report a TDS value BIS uses that value. Where nations do not report a value for TDS, then BIS does not calculate it. The reason is that the different methodologies for arriving at DDS and IDS creates a risk of some double counting, when simply adding the two. We acknowledge this risk of computing TDS values by adding IDS and DDS, but for the purpose of roughly estimating the total value of global debt securities in order to compare with the value of sustainable investments, we deem it defensible to add the two to arrive at a national value of TDS for countries where such a value is not otherwise available.

In summary, we estimated the total amounts outstanding in the Global debt securities markets (TDS) by using the method described in BIS Quarterly Review (BIS 2018, see Graph C1, pp. A11).³² Country-level data is used in our calculations, as follows (see Table S4):

If TDS is reported by BIS for a country, we use this value

If TDS is not reported by BIS, we then calculate a value by adding IDS and DDS

If TDS is not reported, and only IDS is reported, then we use this value as a best estimate of TDS for that specific country.

In line with the BIS we also include the TDS of international organizations in our global estimate, because they are not included in national statistics. International organizations are defined by the BIS as organizations not considered resident of the territories in which they are located or conduct their affairs.

Table S4. Method of computing the total amounts outstanding in the Global debt securities markets (TDS)

Value we used for the aggregation	Country	TDS	DDS	IDS
		Calculated only by national authorities, reported to BIS by nations	Calculated only by national authorities, reported to BIS by nations	Calculated only by BIS from commercial data sources
TDS	Country A	TRUE	TRUE or FALSE	TRUE
SUM OF (TDS +IDS)	Country B	FALSE	TRUE	TRUE
IDS	Country C	FALSE	FALSE	TRUE
NA (zero)	Country D	FALSE	FALSE	FALSE
	...			

2. Market Cap

Market capitalization (also called market value) is the number of shares outstanding for listed domestic companies multiplied by the share price. . We used the 2019 value of the total global domestic equity market capitalization, which has been calculated by Statista and is presented in the “Global domestic

equity market capitalization from 2013 to 2021, by region". ²¹Statista calculated the value by using data provided by Worldwide and World Federation of Exchanges.

3. Private equity

It is notoriously difficult to estimate global private equity as no official database or reporting exists. We used data from Preqin, a commercial provider of data, analytics, and insights targeting the 'alternative' (also known as private) assets community (see discussion above under Debt securities). Preqin data is used by Statista in their reports. According to Preqin¹⁹ the aggregate capital raised by private companies in 2019 was US\$ 729.87bn and the number of private equity funds that closed in 2019 were 1986.

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