Global Standards and Local Ambitions across Green Taxonomies:

Climate change mitigation from the European Union to South Africa

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Abstract

Green finance taxonomy standards have emerged to provide clarity on what economic activities can be considered green for the purpose of attracting investment, protecting financial services consumers and counteracting greenwashing. This paper analyses factors affecting the climate change mitigation ambition level of the South African green finance taxonomy in comparison with the EU's own taxonomy, accounting for (i) the interplay between EU's and South Africa's production and financial networks, and (ii) South Africa's willingness to attract European funding for sustainable development. We find that EU private investors hold more bonds in South African economic sectors with higher ambition level of greenness as determined by the South African green taxonomy. In contrast, EU owned development banks finance South African economic sectors which have a lower green ambition level in the South African taxonomy compared to the EU taxonomy. In addition, South African sectors that export more to the EU tend to signal their virtues with a higher ambition level of greenness. The launch of South Africa's green finance taxonomy has re-allocated bond investment, bank loans, and trade exports from economic activities excluded from the taxonomy to those which are included. Within the sample of economic activities included in the South Africa's taxonomy, our results indicate that EU bondholders of South African companies do not shift their exposure depending on the greenness level of an economic activity post taxonomy launch. However, EU banks increase their loans to South African sectors with the lower ambition level of greenness as compared with the EU taxonomy.

Keywords: standards; green taxonomy; sustainable finance; financial networks; production networks.

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1. Introduction

Climate change, one of the most pressing societal challenges, is an example of the "tragedy of the commons" globally. Despite the efforts of countries, companies and entire global value chains (GVCs) to decarbonise, global emissions have continued to increase over the past two decades (Cojoianu, Ascui, et al., 2021; UN Environment Programme, 2019). The reasons for this include ineffective legislation around the world, the commitment to finance new fossil fuel infrastructure (Pfeiffer et al., 2018), a lack of standardisation on what sustainable economic activities are and how they should work to help achieve the goals of the Paris Agreement (European Commission, 2024).

Economic geographers and innovation scholars have studied standards, focusing on their geography and implications for the environment, particularly within the framework of global production networks (GPNs). However, we have a limited understanding of how global financial networks (GFNs) engage with these standards and allocate funding to sustainable GPNs, which is crucial for spreading and upscaling environmental solutions around the world (Alessi et al., 2024; Wójcik et al., 2024).

(Coe & Yeung, 2019) argue that a major research gap persists at the intersection of GPNs, GFNs and topics of global interest, such as environmental and social issues. This intersection has major practical implications, particularly for sustainable finance standards. Green finance taxonomy standards have emerged exactly at this intersection of GPNs, GFNs and the environment with the goal to clarify which economic activities should be considered sustainable. The UN estimates that over 40 jurisdictions have developed green finance taxonomy standards with different types of design and targeted activities (UN Environment Programme, 2024).

The geography of standardisation in finance is an area which has been understudied by geographers (Clark et al., 2006) and accounting and finance scholars (Lorraine et al., 2001). Our paper aims to fill this gap by studying the adoption of the EU Green Taxonomy by South Africa, and how this adoption has maintained, weakened or strengthened the EU approach in relation to specific economic activities. We study how the EU – South Africa relationships in the GFNs and GPNs influence the ambition of the green taxonomy standards adoption in South Africa. We also examine the influence of

different types of GFN and GPN flows and stocks, including equity, bond, commercial and development bank loans, private equity and venture capital, as well as South Africa – EU trade. Given that green taxonomies are very recent, we follow (Cojoianu et al., 2020; Feldman et al., 2019; Moeen & Agarwal, 2017) and adopt an exploratory research design that allows a nuanced investigation of our questions without committing to explicit hypotheses. We find that GFN actors, particularly bondholders, as well as commercial and development banks are instrumental in shaping the ambition of the green finance taxonomy adoption in South Africa. GPNs also matter, particularly the relative size of South Africa's exports to the EU across different sectors. In addition, the adoption of the green taxonomy positively influences capital flows from EU to South Africa across economic activities included in the taxonomy. A key implication of our findings is that GPNs and GFNs should be studied together when seeking to understand the standardisation, diffusion and performance of sustainable finance.

The paper is structured as follows. In Section 2, we explore the literature on cross-border green standards adoption, and how this is shaped by GPNs and GFNs. Section 3 outlines our data and methodology. Section 4 provides a descriptive and statistical analysis of our findings, with implications and conclusions in Section 5.

2. Theoretical framework

2.1. Sustainable finance taxonomies: between production and financial networks

Climate change and broader environmental issues have become critical drivers of international standardisation efforts (Blind et al., 2023). International Organization for Standardization, for example, has tackled many environmental domains, from climate change finance to corporate environmental management systems and has reaffirmed its commitment to creating standards that are in line with the Sustainable Development Goals (SDGs) (Blind & Heß, 2023; International Organization for Standardization, 2021). Majority of research on environmental standards in geography has focused on GPNs, whether with regard to green office buildings (Eichholtz et al., 2010; Simcoe & Toffel, 2014), energy-efficient appliances (Houde & Aldy, 2017; Houde & Myers, 2021) or emissions standards (Cojoianu et al., 2020; Dechezleprêtre & Sato, 2017). Scholars have addressed compatibility issues

within GPNs, e.g. in the electric vehicle charging infrastructure sector (Li, 2019; Wiegmann et al., 2017), and how environmental standards may promote innovation in GPNs.

In contrast, we know little about standards in finance, particularly those addressing sustainable development challenges, possibly because they are a recent phenomenon. Likewise, the intersection of GPNs and GFNs is a nascent field of research, with examples exploring how GFNs fund different configurations of GPNs (Coe & Yeung, 2019; Cojoianu, Ascui, et al., 2021; Cojoianu, Hoepner, et al., 2021), and GFN impacts on corporate sustainability (Clark et al., 2006; Hoepner et al., 2024). Standards at the intersection of finance and production have been approached from the perspective of corporate governance (Clark et al., 2006), but less through the lens of sustainable finance standards such as green taxonomies or Paris-aligned benchmarks.

The objective of this paper is to study sustainable finance standards and green taxonomies in terms of the ambition with which they tackle the climate crisis and ways in which this ambition is adopted in the Global South. Furthermore, our paper explores the drivers of green taxonomy standard design considering factors related to both GFNs and GPNs. Finally, the paper asks whether the SA Green Taxonomy adoption has enhanced funding opportunities for economic activities covered in the taxonomy.

In the broadest sense, a green taxonomy is a classification system or a data dictionary defining sustainable economic activities, serving as a reference for corporates, investors, and policymakers to make informed decisions regarding effective investment towards solving societal and environmental problems. Amidst the growing number of sustainable finance standards, the emergence of green taxonomies is one of the most noteworthy developments. Since the publication of the European Union (EU) Taxonomy Regulation in 2020, several jurisdictions have prioritised the development of green taxonomies. There are forty-seven jurisdictions that have at least considered issuing a green taxonomy, while twenty-three jurisdictions have already published them (UK Green Advisory Taxonomy Group, 2023).

Given their novelty, literature on green taxonomies is nascent. Emerging studies tackle their potential and actual impacts on financial markets and companies (Alessi & Battiston, 2022; Lee, 2020;

Migliorelli & Dessertine, 2019; Schütze & Stede, 2021). However, we do not know much about the adoption of green finance standards worldwide or how the cross-border relations between the EU as the most sophisticated architect of green taxonomies to date and early adopters in the Global South influence the adoption level of the green finance taxonomy. Economic and financial geographers have much to contribute in this area. Thus, the overarching exploratory research question of our study is:

RQ1. How do global production and financial networks shape the ambition level of green finance taxonomy adoption?

In what follows, we explore several characteristics of standards that promote the harmonisation of action for the SDGs, as well as cross-border adoption of standards, and how the links between production and financial networks can shape the ambition level in the adoption process. Like Lorraine et al. (2001), we define a standard as a widely accepted norm or behaviour encompassing rights and obligations (Goodrick & Salancik, 1996; Krasner, 1983). Practices refer to the regulations and guidelines used to interpret and implement the standard. Diffusion, in turn, is the process through which the standards established by one organization (the standard setter) are adopted by another organization. Finally, we refer to adoption as the outcome of the diffusion process.

2.2. EU Green Taxonomy standard emergence

Standard emergence can occur through different processes (Blind et al., 2023; David & Greenstein, 1990; Farrell & Simcoe, 2012): de facto, with standards developed by individual firms and diffused in a decentralised manner or, de jure, with standards initiated by governments to provide market clarity as guidance or as legally mandated regulations. The final standard typically emerges from the collaboration among private companies, standard-setting organizations (SSOs), and government initiatives (Wiegmann et al., 2017). In our study, we explore the de jure approach to green finance taxonomy development, which was led by the EU Commission and the South African Treasury in their respective jurisdictions, although with slightly different governance and enforcement structures.

The EU Taxonomy Regulation (TR)[1] entered into force in July 2020 after being officially adopted by the European legislative and executive authorities. The TR outlines a general framework for the EU Taxonomy by setting out six environmental objectives and conditions an economic activity must satisfy to qualify as environmentally sustainable. One of the conditions is aligning with the technical screening criteria that are defined in subsequent complementary Delegated Acts.

Our paper focuses on the first Delegated Act[2] , which included technical screening criteria for the first two objectives and has been effective since January 2022. This was also the delegated act available to South African authorities at the time when their own taxonomy was designed (please see Online Appendix 1 for more background).

In designing the EU Taxonomy standard, the EU is seeking to direct the attention of European financial networks and intermediaries towards green production networks embedded across different companies and jurisdictions[3]. EU financial market participants are prompted, partly through the Sustainable Financial Disclosure Legislation (SFDR), to report how much they are investing in EU companies with green economic activities as declared by the EU Taxonomy, regardless of whether these economic activities are in Europe or not. This means that non-EU countries that promote green economic activities that are also aligned with the EU taxonomy can attract foreign direct investment from European financial market participants who want to claim the greenness of their financial products.

Viewed from the supply perspective, standards address a market failure (Hudson & Jones, 2003; Swann, 2010), which in our case is climate change mitigation. While the EU cannot directly regulate green industries in other countries, with a green taxonomy it creates an incentive mechanism for economic activities in other countries to align with the standard, driven by the need to access funding through financial instruments marketed as green in the EU. This cross-border incentive mechanism of the taxonomy is important given that traditional environmental policies and national

1 EU Taxonomy Regulation (Regulation (EU) 2020/852)
2 EU Climate Delegated Act (Delegated Regulation (EU) 2021/2139)
3 For recent research on the EU Taxonomy itself, see Alessi et al. (2024), Bassen et al. (2024), Hoepner and Schneider (2022, 2024) or Sautner et al. (2024).

social movements (e.g. the fossil fuel divestment movement) struggle to constrain environmentally unsustainable corporate activities of their home companies abroad (Cojoianu, Ascui, et al., 2021).

Viewed from the demand side, the EU has introduced the taxonomy given the high demand for sustainable financial products across Europe, but also to address confusion and lack of standardisation among financial product providers on what green means. This dynamic has been documented as a reaction of regulators to aid product innovation - common when emergent sectors grow and get attention of regulators (Georgallis et al., 2019; Porter, 1998; Su et al., 2015).

2.3. Green Taxonomy Diffusion and Adoption: The Case of South Africa

The potential dynamics of diffusion and adoption of green taxonomies are somewhat predictable. International standards have been particularly successful in periods of market expansion and globalisation, which applies to the growth of environmental finance and green technologies after the Paris Agreement (Blind et al., 2023; Swann, 2010). Meanwhile, expansion in cross-border trade has enabled and been enabled by national and international standards development (Bernhofen et al., 2016; Brooks et al., 2021; Levinson, 2016).

The EU has been a standard setter in green finance development, given the robustness of its taxonomy, but also the desire of many Global South trading partners to attract financial flows from Europe. This is confirmed by South Africa's Finance Minister's statement:

"The green finance taxonomy is one such framework that reduces the costs and uncertainty in classifying a core set of green activities and promotes information transparency. By following the model adopted by the European Union, we are ensuring that the domestic financial sector is aligned with international best practices and providing international investors with clarity and conviction to invest in South African green projects. Where appropriate, we have made adjustments for country-specific circumstances whilst maintaining the environmental integrity and science-based targets necessary to meet the goals of the Paris Agreement." (Mr Enoch Godongwana, South Africa's Minister

of Finance, Foreword, "A Comparison between the European Union and South Africa Green Taxonomy"[4], November 2022).

In 2022, South Africa became the first African country to publish a Green Finance Taxonomy[5]. Its first version was published in April 2022 and endorsed by the National Treasury, which is one key difference between the EU Taxonomy and the RSA GFT. Whereas the former is a legal document under an official regulation – the EU Taxonomy Regulation, the latter is a guidance document with public endorsement of the National Treasury. The first version of the RSA GFT defines the same six environmental objectives as the EU Taxonomy, and includes criteria for eligible economic activities for the first two environmental goals.

According to the RSA GFT, and similarly to the EU Taxonomy, to be aligned, an activity must satisfy three sets of tests. One minor divergence concerns minimum safeguards. The RSA GFT refers to national regulations on labour codes and human rights instead of international standards. To develop the first version of the taxonomy, the National Treasury chaired a steering committee in conjunction with the Banking Association of South Africa. Under this steering committee, the Taxonomy Working Group was established with representatives from government agencies, financial authorities, financial market participants, and development agencies[6] The National Business Initiative (NBI) and Carbon Trust, under the leadership of the Taxonomy Working Group, were chosen to carry out research, stakeholder consultation, and drafting the taxonomy for the first phase. Apart from considering national legislation, the development process of the SA GFT leveraged different elements from existing green taxonomies that were reshaped and adopted to accommodate South Africa's socioeconomic development needs. It also benefitted from continuous engagement with various stakeholders across the financial sector, which could test the taxonomy and provide feedback on usability and disclosure requirements.

4 Cojoianu, Hoepner & Vu (2022) 'Comparison of the EU Green Taxonomy with South Africa's Green Taxonomy' Brussels: European Union Directorate General for International Partnerships.
5 National Treasury (2022): the first edition of South African Green Finance Taxonomy (Accessed on 24 October 2023)
6 National Treasury (2022): Development process for the South African Green Finance Taxonomy (Accessed on 24 October 2023)

Literature has shown that standard diffusion is shaped by cross-border flows of trade, labour, and finance. Lorraine et al. (2001) argue that the greater the volume and types of cross-border linkages between two jurisdictions, the stronger the cross-border diffusion. However, prior research does not suggest which interdependencies may be more important and in what context. Historically, studies on GPNs have focused on the role of lead firms and their interactions with suppliers (Pasquali et al., 2021). More recent literature focuses on how industrial, trade and labour policies shape the geography of GPNs (Curran et al., 2019). Our study puts GPN and GFN links side by side, proposing that economic geographers can understand standards adoption and diffusion much better when the effects of GFNs are taken into account.

Given that South Africa decided to follow the EU taxonomy, our goal is to understand how ambitious the South African taxonomy is compared to the EU's, for each economic activity covered by both taxonomies. In addition, the study investigates whether the adoption of the green taxonomy has enhanced capital flows between the EU and South Africa, and whether this has been influenced by the stringency of adoption.

Implicit in Minister Godongwana's statement above is that South Africa did not opt for a full harmonisation, but instead pursued a standard-setting approach which (Lutz & Pezzino, 2012) call national treatment. Given that both the EU and the South African green taxonomies define sustainability standards for each individual economic activity (e.g. wind energy, battery storage or steel manufacturing), the discretion in South Africa's adoption of the taxonomy is exercised with regard to individual economic activities, reflected in the degree to which South Africa adopts the EU criteria with similar, more or less ambition. Given that the South African green taxonomy aims to attract green capital flows from Europe, we could suspect that when the EU-RSA GFN connections at the individual economic activity level are more intense, the more likely South Africa is to adopt a similar or higher sustainability ambition for this economic activity, and that this impact is stronger for GFN than for GPN connections. This leads to the second research question:

RQ2: How do EU-RSA GFN connections compare with their GPN connections in terms of their impact on the ambition of green taxonomy standard adoption in South Africa?

2.4. Green taxonomy standards – primary capital markets, debt and adoption effects

Both the EU and South African green taxonomies aim to attract new capital flows into sustainable economic activities. These are financed through primary capital markets, i.e. the issuance of new bonds, loans, or equity. Debt is particularly important for capital-intensive sectors, ranging from renewable energy (Steffen, 2018) through agriculture (Ascui & Cojoianu, 2019) to fossil fuels (Cojoianu, Ascui, et al., 2021; Cojoianu, Hoepner, et al., 2021). Debt instruments especially green bonds with lower cost of capital have become increasingly prevalent in financing sustainable economic activities as those instruments (Flammer, 2021). Research on GFNs and financial centres has shown that the prominence of many leading financial centres lies in the proliferation of investment banking services such as bond and equity underwriting and syndicated lending (Wójcik et al., 2019).

For many developing countries, development banking has been a prime driver of foreign direct investments for both sustainable development purposes (Yuan & Gallagher, 2018) and for derisking GPNs to attract follow-on funding from other investors such as commercial banks (Eslava & Freixas, 2021). Given this background, we anticipate that GFNs related to the debt channel are more influential in shaping the ambition level of the South African green taxonomy than equity-related GFNs (public or private equity). Furthermore, given that EU commercial banks are required to report the proportion of their lending book to green taxonomy aligned activities, and EU development banks are not, we further explore two related questions:

RQ3: Are debt-related GFNs more impactful than equity-related GFNs in ensuring an ambitious green taxonomy standard adoption?

RQ4: Are commercial banking GFNs more impactful than development banking GFNs in ensuring an ambitious green taxonomy standard adoption?

Having explored in depth the determinants of the stringency of standard adoption, our study also contributes to the literature on their effects, in the guise of capital flows and enhanced GFN activity between the two jurisdictions. (Nadvi, 2008) highlights that many standards and governance structures, particularly related to GPNs, haven't necessarily delivered the expected changes (e.g.

prevalence of child labour). Are GFN-related standards more effective? Can we observe any enhanced capital flows as a result of the Green Taxonomy adoption? (Cojoianu, Ascui, et al., 2021) shows that GFNs can easily navigate pollution havens and finance economic activities in economies with the least ambitious environmental policy stringency. In this respect, the final research question of our paper is:

RQ5: Has SA's Green Taxonomy adoption enhanced debt capital flows from the EU towards South Africa?

3. Data and methodology

3.1. Dependent variables

SA Green Taxonomy Ambition Level

In this section, we provide the rationale for dependent and independent variables used in our analysis. For each economic activity deemed important to climate change mitigation, we assess whether the adoption of the sustainability criteria by the South African Green Taxonomy has been less ambitious, similar or more ambitious than the EU Taxonomy.

Our comparison of the two taxonomies is based on the criteria set out in the first version of the South Africa Green Finance Taxonomy and the EU Climate Delegated Act (C/2021/2139). We employ the following methodology. First, we match similar sectors across the two taxonomies to carry out an in-depth comparison by economic activity. Within each matched sector, we identify similar activities based on their names and descriptions in the EU Taxonomy and the RSA GFT. Sectors and economic activities codes differ slightly between the EU Taxonomy and the South Africa Green Finance Taxonomy, because the EU uses the NACE classification system while South Africa uses the SIC classification system.

As a next step, we compare the substantial contribution to climate change criteria of the RSA GFT's activities to those of the EU Taxonomy in quantitative and qualitative terms. Three of our five authors have independently reviewed all substantial contribution criteria leading to four categories[7]: (i) incomparable, (ii) similar, (iii) the RSA Taxonomy is more ambitious/ more detailed than the EU

[7] Detailed methodology is provided in Appendix OA.3. In case the three authors came to diverging results, these cases were resolved in the ex-post validation with staff of the South African National Treasury and the European Commission's DG INTPA.

Taxonomy, and (iv) the RSA Taxonomy is less ambitious/ less detailed than the EU Taxonomy.The first category applies to criteria for the Agriculture, forestry and fishing sectors. While the RSA GFT follows the Climate Bonds Initiative's Forestry and Land Conservation & Restoration Criteria and South African Sustainable Forest Development Policy, the EU taxonomy refers to European standards. The second category is applicable in cases in which both taxonomies have a similar number of requirements and thresholds. For the third category, it is the case that the RSA Taxonomy a higher number of requirements and/or more detailed requirements. Finally, the fourth category means that the RSA Taxonomy has fewer requirements and/or less detailed requirements.

As we are interested in comparing the level of ambition between the RSA GFT and the EU Taxonomy, the dependent variable is ordered and categorical, indicating the comparison from the RSA GFT's perspective. We validated our coding of ambition levels in discussions with both staff of the South African National Treasury and the European Commission's DG INTPA. Each criterion was considered validated only if staff from both organisations were satisfied with it, which helps avoid bias towards either the European or South African side in our research design[8]. A total of 87 activities were categorised.

3.2. Independent variables

All variables are on the level of economic activity which was mapped to the industry classification of each company. In theory, the taxonomy allows for mapping companies to multiple types of economic activities they are involved in. However, given the lack of data on this distribution within each company, we map the taxonomy to each company's main economic activity proxied by the sub-industry classification. Detailed definitions of all variables are presented in Appendix A.5.

3.2.1. Global Financial Network Factors

EU investors' holdings of bonds in South African companies

The variable is on an economic activity level. We consider all bonds listed by South African companies on the JSE as of 31 December 2021, according to Bloomberg. After matching the issuing companies to

[8] Cojoianu, Hoepner & Vu (2022) 'Comparison of the EU Green Taxonomy with South Africa's Green Taxonomy' Brussels: European Union Directorate General for International Partnerships.

the taxonomies based on their primary industry, we calculate the share of EU investors' bond holdings in total bond ownership. We aggregate firm-level data that have been matched with the taxonomies to economic activity level and calculate the share of EU investors in total bond holdings ("EU bonds").

EU investors' holdings of equities in South African companies

We use information from Bloomberg on the shareholders of 143 South African companies listed on the Johannesburg Stock Exchange (JSE) as of 31 December 2021 – the year before the publication of the RSA GFT. We matched the primary industry of these companies to the taxonomies and identified EU-based and non-EU shareholders. We also matched their main business activity with activities listed in the taxonomies. The variable ("EU equities") is aggregated to economic activity level from firm-level data and measured as the share of EU investors in total equity ownership. Similarly to "EU bonds" variable, "EU equities" variable is also on the basis of economic activities.

EU investors' venture capital investments in South African companies

The variable is on an economic activity level. We obtained a list of South African companies receiving venture capital from 2016 to 2020 from Preqin. We matched these companies to eligible taxonomy activities based on the description of the companies in Preqin database. Next, we measured the share of EU-based investors in these deals and take a five-year average percentage ("EU VC") to account for the volatile flows of venture capital from the EU to South Africa.

EU banks' underwriting of syndicated loans, bonds, and equities for South African companies

Under the EU Taxonomy Regulation, the banking sector is subject to increased disclosure regarding its investment processes and green products. As a result, it is expected that the more South African companies rely on financing from EU banks, the more likely that the RSA GFT's ambition would be at least similar to that of the EU Taxonomy to facilitate continued financing into South Africa.

For this economic-activity-level variable, we employ the Dealogic database on primary market financing deals, covering syndicated loans, bonds, and equities. From 2016 to 2020, there were 3,921 deals related to companies headquartered in South Africa. EU-based banks underwrote 686 deals or 17.5% of the total deals. We matched South African companies with the taxonomies based on their primary standard industrial classification (SIC) codes and business descriptions. Then, we

quantified the proportion of financing that EU banks underwrote, aggregated on activity level, and averaged to arrive at the five-year proportion of EU banks providing underwriting services to South African companies ("EU commercial banks") over the total amount of underwriting deals provided by both EU and non-EU banks to South African companies. When testing whether the introduction of the taxonomy has enhanced banking flows from the EU to SA, we update our dataset with SDC Dealscan to enable the before and after statistics.

EU Development Bank underwriting of loans, bonds, and equities for South African companies

To arrive at this variable ("EU development banks"), we adopt the same Dealogic database as the previous variable. We collated a list of development banks worldwide and found their matches in the Dealogic database. The remaining calculation process was similar to the variable "EU commercial banks".

3.2.2. Global Production Network Factors

EU and SA GVA and Market Capitalisation

We include EU's and South Africa's gross value added (GVA) by sector from MarketLine. We quantify the share of each sector in each jurisdiction's GVA and take the average for the five-year period from 2016 to 2020. Acronyms used are "EU GVA" and "RSA GVA". They are both sector-level variables.

Additional variables are the proportions of taxonomy-eligible sectors defined as the ratio of the aggregated market capitalisation of companies listed in a taxonomy-eligible sector divided by all listed companies in the most prominent EU and South African stock exchange indices. We operationalise these variables by obtaining data from MSCI World holdings as of December 31, 2022. For the EU, the data are based on the EXSA Fund of MSCI, which tracks the performance of an index of the 600 largest companies from European countries. For South Africa, we use the EZA Fund from MSCI which tracks an index of South African equities. The variables are coded "EU stock exchange" and "RSA stock exchange", respectively.

South Africa's commodities export to the EU

Using data from UN Comtrade, we focus on the export of commodities from South Africa to the four biggest economies in the EU by size (i.e. Germany, France, Italy, and Spain), as well as to the

Netherlands, given its historical ties to South Africa. According to the European Commission (2023), South Africa's main exports to the EU are fuels and mining products. We take the share of South African exports to those five EU countries in total South African exports to the world for each economic activity matched with the taxonomies. The variable ("RSA export") is calculated as an average of a five-year period from 2016 to 2020. The variable is on an economic activity level.

3.3. Model specification

We are interested in exploring the relationship between the level of ambition of the RSA GFT and the three types of cross-border flows between the EU and South Africa. The ambition level variable is categorical and ordered (i.e., less ambitious, similar, and more ambitious). Ordinal data have been widely used in such fields as psychology, medicine, economics, and consumer choice (Liddell & Kruschke, 2018). Consequently, we employ an ordered probit model in our empirical models. The conceptual construction of an ordered probit is a utility function in the form of a latent regression as follows:

$$y^* = x'\beta + \varepsilon \ (Equation\ 1)$$

Where $y^*$is unobserved, β is a set of covariates to be estimated and ε is normally distributed across observations. We can only observe the categories, or in this case, the assigned comparison of ambition level between the two taxonomies. Formally, our model is below:

$$\begin{aligned} Comparison\ of\ ambition\ level_i^* &= \beta_1 + \beta_2 EU\ equities_i + \beta_3 EU\ bonds_i + \beta_4 EU\ stock\ exchange_i \\ &+ \beta_5 RSA\ stock\ exchange_i + \beta_6 EU\ GVA_i + \beta_7 RSA\ GVA_i + \beta_8 RSA\ export_i \\ &+ \beta_9 EU\ VC + \beta_{10} EU\ commercial\ banks + \beta_{11} EU\ development\ banks \\ &+ \varepsilon_i \ (Equation\ 2) \end{aligned}$$

We use the command "oprobit" in STATA to estimate the model.

To initially examine the impact of the South African Green Finance Taxonomy on financing flows from the EU to South Africa, we run difference-in-difference regressions for the period from 01 April 2020 to 31 March 2024 for investors holding bonds in South African companies as well as commercial banks underwriting syndicated loans for South African companies. The analysis focuses

on: (i) whether there is an increase in financing flows (via bond holdings, equity holdings, and syndicated loans underwriting) and trading flows (via commodity exports from South Africa to the EU in taxonomy-eligible economic activities in South Africa and (ii) whether there is an allocation, among the taxonomy-eligible activities, from the less ambitious activities to activities with at least the same ambition as the EU Taxonomy. As the RSA GFT was launched on 01 April 2022, we include 24 months on each side of the launch date to create panel datasets.

The equation (excluding firm controls and fixed effects) for (i) can be written as

$$Financing\ flows\ or\ Trading\ flows = \beta_0 + \beta_1 EligibleActivities + \beta_2 AfterRSAGFT + \beta_3 EligibleActivities * AfterRSAGFT\ (Equation\ 3)$$

The equation (excluding firm controls and fixed effects) for (ii) is

$$Financing\ flows\ or\ Trading\ flows = \beta_0 + \beta_1 ActivitiesSameOrHigherAmbition + \beta_2 AfterRSAGFT + \beta_3 ActivitiesSameOrHigherAmbition * AfterRSAGFT\ (Equation\ 4)$$

For bond holdings and equity holdings, our dependent variable is EU private investors' percentage of ownership of outstanding bonds or shares of of each South African company included in our sample. The date of disclosure of investor ownership, or filing date, is used to determine whether the ownership is before or after the launch of the RSA GFT (i.e. 01 April 2022). In accordance with (Hu et al., 2024; Zaghini, 2024), we include bond issuer controls such as asset-to-liability ratio, credit ratings, sector, and whether the issuer is listed. In addition, for listed companies, as control variables we include market capitalisation, book-to-market value, leverage ratio, capital expenditure, property plant and equipment (PPE), and long-term growth estimates (Bolton & Kacperczyk, 2023). We use data from Refinitiv for syndicated loans because of the availability of up-to-date loan deals. The dependent variable is the percentage of the loan package amount for each commercial bank involved in the syndicate managing the loan for South African companies. The date to determine whether a loan is post-RSA GFT is the date the loan is originated. Similarly to the bond analysis, we control for asset-to-liability ratio, credit ratings, sector, and whether the issuer is listed on the issuer's (borrower) side. For South African commodity exports to the EU, the data are from UN Comtrade. We

use exports data on aggregated on a monthly basis. The dependent variable for the difference-in-difference model is the estimated value amount free on board (FOB).

4. Descriptive statistics

Table 1 displays the distribution of each comparison level across sectors for climate change mitigation. For activities contributing to mitigation, out of 87 sets of criteria, 52 or 60% of them in the RSA GFT are at least similar to those in the EU Taxonomy. The energy sector is the sector in which the RSA GFT has the largest number of more ambitious/ more detailed criteria than the EU Taxonomy. This is mainly due to the declining thresholds of greenhouse gas (GHG) emissions criteria specified in the RSA GFT. At the same time, the EU Taxonomy does not require energy producers to cut their emissions gradually to net zero. The other sector in which the RSA GFT has more ambitious/more detailed criteria than the EU Taxonomy is the water supply, sewerage, and waste management sector. These criteria are for two activities involving capturing emissions (e.g. Direct Air Capture of CO2 and Capture of Greenhouse Gas Emissions) included in the RSA GFT but not in the EU Taxonomy.

Table 2 shows the 20 largest South African companies by market capitalisation and their potential inclusion in the two taxonomies based on their primary industrial classifications. Three companies can be identified as a match with the manufacturing of iron and steel. However, 12 of these companies could not be matched with any activities in both taxonomies, which is not unreasonable given that even the EU Taxonomy is still being developed further as of March 2025. Appendix A.7 and A.8 show the total aggregate amount of financing that the top 10 EU commercial banks and development banks involve in South African companies from 2016 to 2020. German and French banks are featured in high positions in both tables.

[Insert Table 1 and 2]

Figure 1 demonstrates that for both bond and equity of EU investors in South African companies, the construction and real estate sector has the largest holdings. The manufacturing and financial sectors are also among the top holdings of EU investors in RSA companies. Figure 2 shows EU investors' bond and equity holdings in South African companies by ambition levels aggregated at sector

level. While most EU bond holdings are in South African sectors with similar criteria, half of EU equity exposure to South Africa is in sectors with less ambitious/ less detailed criteria than those of the EU Taxonomy. We perform the same analysis with EU commercial and development banks (Figures 3 and 4). EU commercial banks underwrite financing deals for South African companies across many sectors, whereas EU development banks focus on three sectors (i.e. ICT, energy, and financial sectors). Figure 4 highlights that almost all the deals underwritten by EU development banks are in the less ambitious/ less detailed criteria sectors.

[Insert Figure 1, 2, 3and 4]

5. Statistical analysis

Table 3 (Model 1 – 10) shows the results of the ordered probit regression. They demonstrate that the more important a sector is in the JSE equity index, the less ambitious its criteria are as compared to those of the EU Taxonomy. This may be an indicator of corporate lobbying, whereby listed companies in sectors with high market capitalisation reduce the number of substantial criteria applicable to their primary industries in comparison with the EU Taxonomy. For example, in the JSE equity index, the ICT and financial sectors combined account for more than 50% of total market capitalisation, but on aggregate, the level of ambition of the RSA GFT in these two sectors is consistently lower than that of the EU Taxonomy. In addition, the relationship between the ambition level and the proportion of sectors in the EU equity index is significantly negative. This suggests that for a sector that accounts for a lower proportion in the EU equity index, the RSA GFT has higher ambition level for it against the EU Taxonomy (e.g. energy, waste). This may be interpreted as an attempt by South Africa to signal its green virtues.

The result for "EU GVA" indicates that for an activity or sector contributing significantly to the EU's gross value added, the criteria of the RSA GFT are less ambitious than those of the EU Taxonomy. Another finding is the role of commodity exports from South Africa to the EU in determining the level of ambition of the RSA GFT. It is shown that the more South Africa exports a particular good to the EU, the higher likelihood that South Africa assigns a high level of ambition for the particular economic

sector in the Taxonomy. This shows the importance of manufacturing in South Africa, a sector with RSA GFT's substantial contribution criteria that include more details than and are similar to those of the EU Taxonomy.

Overall, listed companies in South Africa seem to be exposed to less ambitious criteria in the GFT, but at the same time, the GFT – a market-led initiative, sets higher requirements in sectors that account for a large proportion of the EU equity index, possibly signalling South African green transitions in such sectors. This signal of green virtue can also be observed in the more ambitious criteria set for the country's manufacturing of commodities exported to the EU. Since the EU is one of the most significant trade partners of South Africa, the results reflect a positive relationship between trade volume and the level of harmonisation of the two green taxonomies.

[Insert Table 3]

To further understand how financial flows between the EU and South Africa and which complementary or diverging roles public and privately funded institutions play, we look at the number of financing deals underwritten by EU banks and link them with the shaping of ambition level of the RSA GFT. First, for the variable "EU commercial banks" and "EU development banks", we narrow the analysis down to financing deals underwritten by these two types of banks (i.e. commercial vs. public banks) for South African companies that have their bonds listed on the Johannesburg Stock Exchange as of December 31, 2021. Second, we select South African companies listed (listed equities) on the JSE as of December 31, 2021, and then quantify the amount of financing for these companies from EU commercial banks and EU development banks, respectively. Afterwards, we run the regression with these two new variables replacing "EU commercial banks" and "EU development banks". The results are displayed in Table 4 and Table 5.

When filtering financing deals for South African companies with listed bonds, EU investors' bond holdings in these companies seem to make the substantial contribution criteria of the RSA GFT more ambitious than those of the EU Taxonomy. The negative relationship between the proportion of sectors in JSE and the level of ambition of the RSA GFT still holds for the bond-listed model (Table 4). More consistently, the more important a sector is in the gross value added of the EU economy, and the

less ambitious the RSA GFT's criteria are compared with those of the EU Taxonomy. It is the case that the important sectors in the EU economy are not the same as in the South African economy, which is more focused on mining and manufacturing. For the equity-listed companies' model (Table 5), EU commercial banks' financing into the South African economy helps shape the higher ambition level of the RSA GFT, which could be seen as a way that listed South African companies anticipate the effects of EU Taxonomy Regulation on relevant financial institutions operating both in the EU and in South Africa.

[Insert Tables 4and 5]

Regarding the difference-in-difference regressions, results from Table 6 show that two years after the launch of the South African Green Finance Taxonomy, there seems to be a statistically significant increase in bond holdings in South African companies, whose activities may be eligible under the RSA GFT. However, among those eligible activities, the allocation towards economic activities with similar or more ambitious criteria than those of the EU Taxonomy is not significant (Table 7).

[Insert Table 6 and 7]

For equity holdings, Table 8 and Table 9 demonstrate that although there is a slight decrease in shareholdings of listed South African companies after the launch of the RSA GFT, investors seem to increase their holdings in companies that operate in activities with lower ambition level criteria than the criteria of the EU Taxonomy.

[Insert Table 8 and 9]

Table 10 demonstrates that commercial banks seem to underwrite more loans for companies operating in activities eligible under the RSA GFT, but the underwriting volume of commercial banks for South African companies whose activities have the same criteria as or more ambitious criteria than those of the EU Taxonomy seems to decrease after 01 April 2022 (Table 11). Hence, our results indicate that while bondholders are ambition agnostic, banks increase loans in activities the South African taxonomy classifies as green, particularly when the ambition level is lower. Results with trading flows from South Africa to the EU also confirm the role of the RSA GFT in South African economy. After the launch of the Taxonomy, exports of commodities to the EU increase in activities that are eligible under

the Taxonomy (Table 12), but similarly to the results of syndicated loans underwriting, the increase is in activities with lower ambition level than that of the EU Taxonomy.

[Insert Table 10,11,12, and 13]

6. Implications and conclusion

Building on previous literature on the role of GPNs and GFNs in standards adoption, our study shows that production and financial networks between the EU and South Africa are important in ensuring an ambitious adoption of the green finance taxonomy. We find that in sectors or economic activities where more EU investors hold bonds in South African companies, the RSA GFT's criteria are likely to be more ambitious or more detailed than those of the EU Taxonomy. This may be due to the favourable impacts of foreign investors on the corporate governance of companies, which in turn play a large role in developing a bottom-up green taxonomy initiative in South Africa[9].

Second, commodity exports from South Africa to the EU's biggest economies seem to positively affect the ambition level of the RSA GFT as compared with the EU Taxonomy, which reinforces the critical role of commodity manufacturing in the South African transitions to sustainability in the context of climate change mitigation. Finally, while the constructive role of development banks' investments in emerging economies is not to be underestimated, their financing deals in South African companies do not appear to shape the ambition of the RSA GFT vis-a-vis the EU Taxonomy. It may be the case that although green taxonomy is gaining momentum as an investment decision reference, development banks have their own taxonomies that follows a different approach to the one adopted by both the EU and South Africa. The divergent taxonomy designs and choices are the main obstacles for green taxonomy (Chan et al., 2023; Fronda, 2023).

Third, additional analysis from difference-in-difference regressions highlights the role of GFNs in South Africa after the launch of the RSA GFT. Results indicate that although there is a positive sign in activities eligible under the RSA GFT in relation to bond holdings and loan underwriting, the

[9] As note 6 above.

allocation to activities with criteria that at least match the ambition level of the EU Taxonomy remains unchanged.

These findings have implications applicable to a wide range of audiences. For economic and financial geographers, the study highlights that green finance standards are an important setting to study how GFNs and GPNs collide to shape sustainability outcomes. As more and more jurisdictions will be introducing their green taxonomies, further research into the diffusion and adoption processes of green taxonomies may be extended based on the present study. We also provide evidence towards Coe & Young's (2019) call to study GPNs, GFNs, and sustainability outcomes in an integrated way.

For policymakers considering adopting a green taxonomy, it is important to recognise the role of financial and trading ties with other jurisdictions in shaping the ambition level in the adoption process. Policymakers at development banks can review their financing facilities to emerging countries to accelerate the low-carbon transition in these countries by ensuring an ambitious adoption of green taxonomies.

The paper has certain limitations regarding the granularity of data on an economic activity basis. However, we have accommodated this by replacing activity-level data with sector-level data. Furthermore, as it is a policy, albeit not mandatory yet in South Africa, the green taxonomy design is affected by more than just economic and financial relationships. Subsequent studies could expand the scope of independent and control variables to include such factors as institutional governance and social awareness and acceptance of the policy. Finally, for the green taxonomy to become an effective tool to scale up sustainable finance and tackle greenwashing, it would be beneficial if future studies could examine how existing sustainable finance initiatives such as sustainability reporting, green bonds, and the EU Paris-Aligned Benchmark could contribute to creating a comprehensive regulatory framework built on a green taxonomy.

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7. Figures and Tables

7.1. Figures

Figure 1: EU Taxonomy alignment: top-level view and an example showing a company is a collection of different economic activities

Climate change mitigation		
Technical Screening Criteria		
Company A	**Substantial Contribution**	**Do no significant harm**
Activity 1: Manufacture of batteries	The economic activity manufactures rechargeable batteries, battery packs and accumulators (and their respective components), including from secondary raw materials, that result in substantial GHG emission reductions in transport, stationary and off-grid energy storage and other industrial applications. The economic activity recycles end-of-life batteries.	DNSH on climate change adaptation: The activity complies with the criteria set out in Appendix A to this Annex. DNSH on water: The activity complies with the criteria set out in Appendix B to this Annex. DNSH on circular economy: For manufacturing of new batteries, components and materials, the activity assesses the availability of and, where feasible, adopts techniques that support: reuse and use of secondary raw materials and reused components in products manufactured; design for high durability, recyclability, easy disassembly and adaptability of products manufactured; information on and traceability of substances of concern throughout the life cycle of the manufactured products. Recycling processes meet the conditions set out in Article 12 of Directive 2006/66/EC of the European Parliament and of the Council (91) and in Annex III, Part B, to that Directive, including the use of the latest relevant Best Available Techniques, the achievement of the efficiencies specified for lead-acid batteries, nickel-cadmium batteries and for other chemistries. These processes ensure the recycling of the metal content to the highest degree that is technically feasible while avoiding excessive costs. Where applicable, facilities carrying out recycling processes meet the requirements laid down in Directive 2010/75/EU of the European Parliament and of the Council (92). DNSH on pollution prevention: The activity complies with the criteria set out in Appendix C to this Annex. Batteries comply with the applicable sustainability rules on the placing on the market of batteries in the Union, including restrictions on the use of hazardous substances in batteries, including Regulation (EC) No 1907/2006 of the European Parliament and of the Council (93) and Directive 2006/66/EC. DNSH on biodiversity: The activity complies with the criteria set out in Appendix D to this Annex.
Activity 2: Storage of electricity	The activity is the construction and operation of electricity storage including pumped hydropower storage. Where the activity includes chemical energy storage, the medium of storage (such as hydrogen or ammonia) complies with the criteria for manufacturing of the corresponding product specified in Sections 3.7 to 3.17 of this Annex. In case of using hydrogen as electricity storage, where hydrogen meets the technical screening criteria specified in Section 3.10 of this Annex, re-electrification of hydrogen is also considered part of the activity.	DNSH on climate adaptation: The activity complies with the criteria set out in Appendix A to this Annex. DNSH on water: In case of pumped hydropower storage not connected to a river body, the activity complies with the criteria set out in Appendix B to this Annex. In case of pumped hydropower storage connected to a river body, the activity complies with the criteria for DNSH to sustainable use and protection of water and marine resources specified in Section 4.5 (Electricity production from hydropower). DNSH on circular economy: A waste management plan is in place and ensures maximal reuse or recycling at end of life in accordance with the waste hierarchy, including through contractual agreements with waste management partners, reflection in financial projections or official project documentation. DNSH on pollution prevention: N/A. DNSH on biodiversity: The activity complies with the criteria set out in Appendix D to this Annex.

Figure 2: EU investors' bond and equity exposure to South African companies by sectors

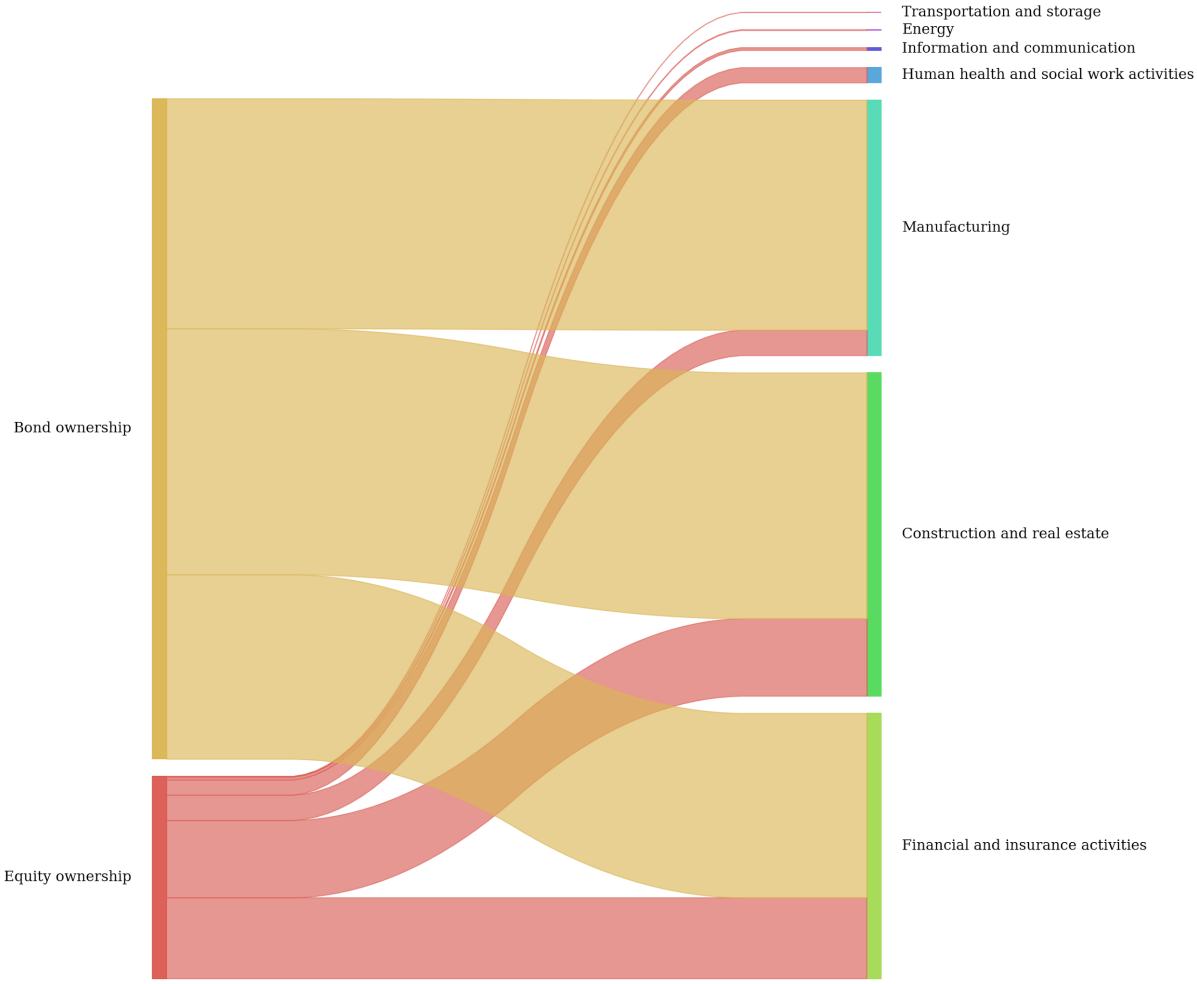


Figure 3: EU investors' bond and equity exposure to South African companies by ambition levels

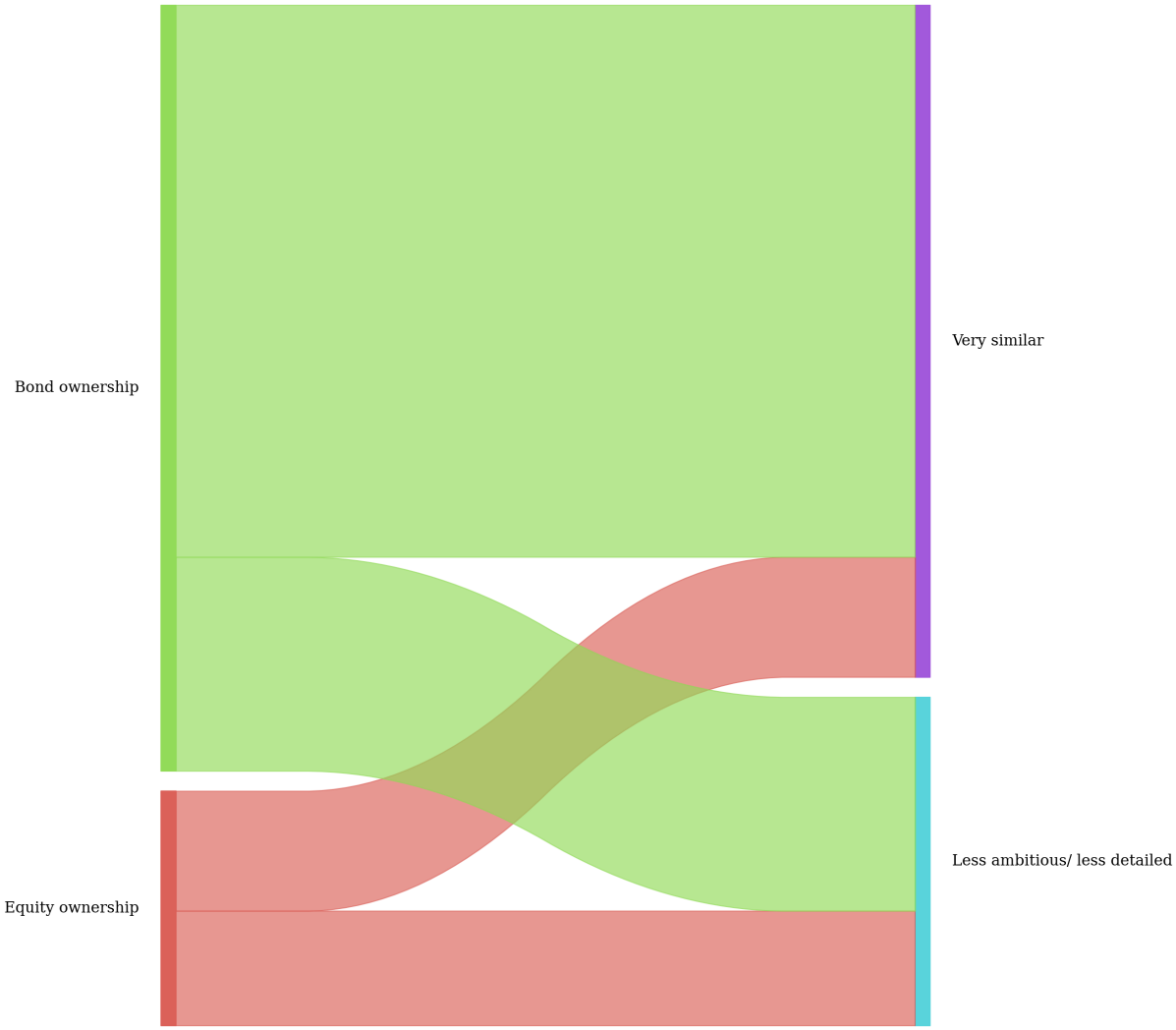


Figure 4 EU development banks and commercial banks financing deals with South African companies by secto

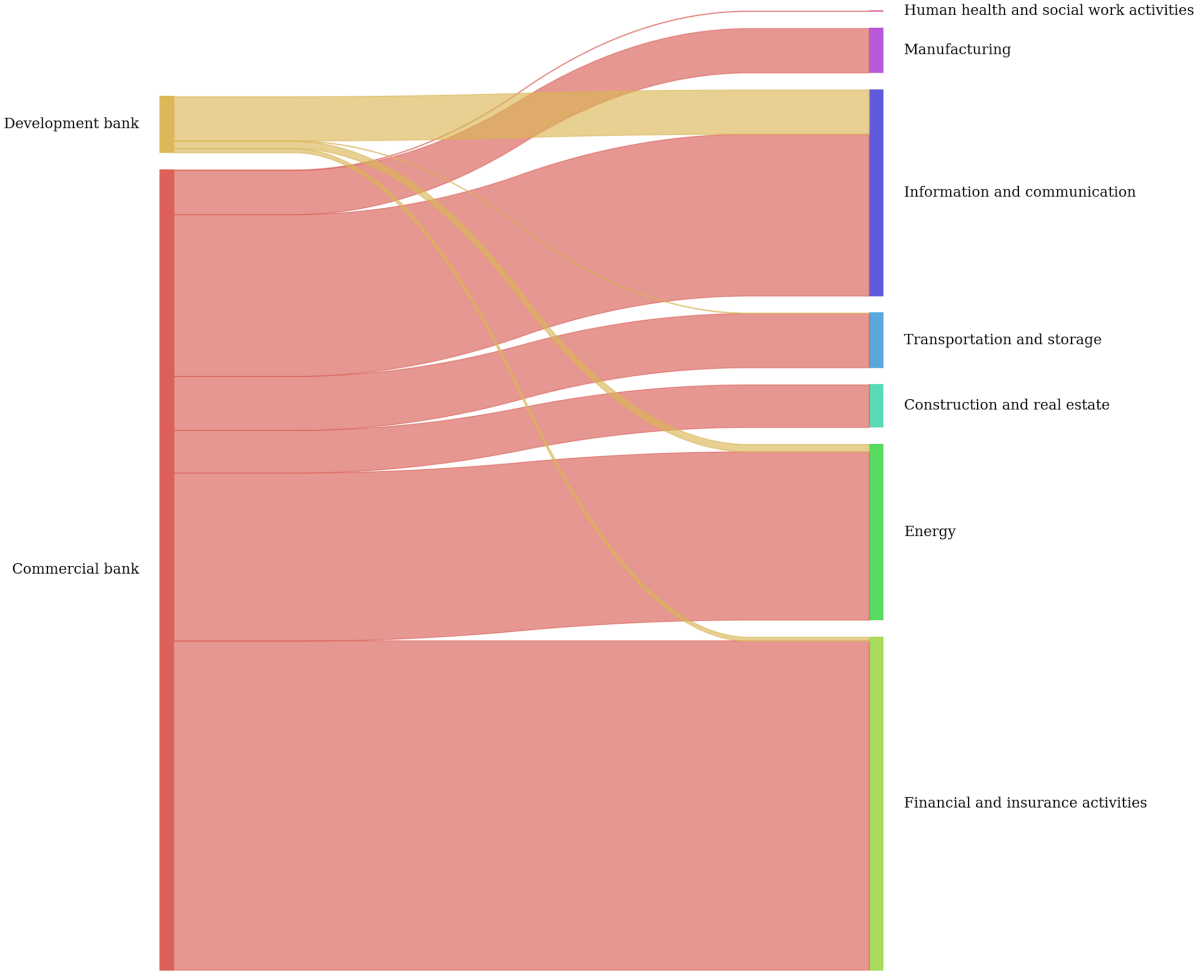
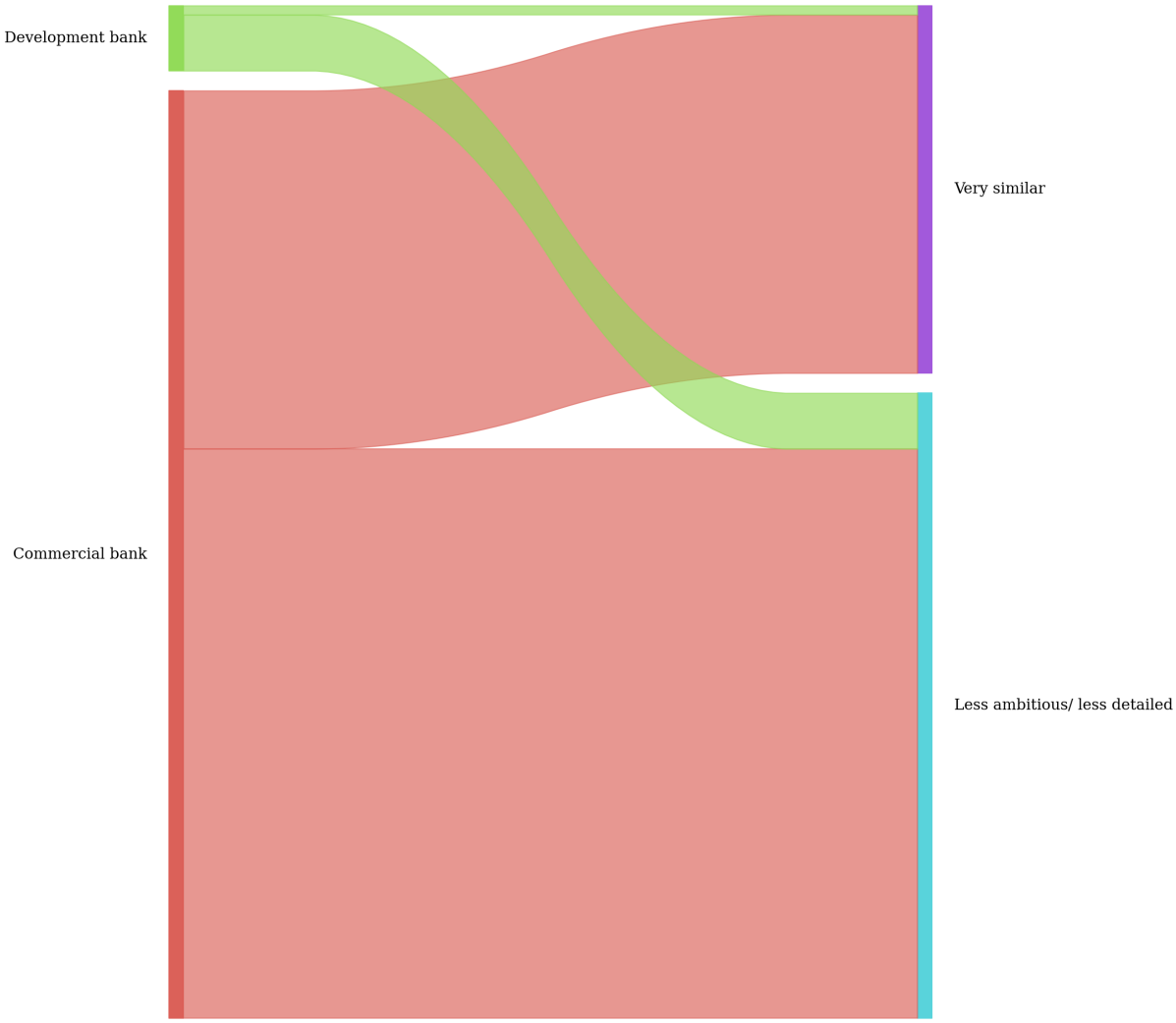


Figure 5: EU development banks and commercial banks financing deals with South African companies by ambition level



7.2. Tables

Table 1: The number and proportion of three ambition level categories across sectors (climate change mitigation criteria)

Sector	Less ambitious (number of activities)	Similar (number of activities)	More ambitious (number of activities)	Less ambitious (%)	Similar (%)	More ambitious (%)
Construction and real estate	3	4	0	8.57%	10.00%	0.00%
Energy	6	12	7	17.14%	30.00%	58.33%
Environmental protection and restoration activities	1	0	0	2.86%	0.00%	0.00%
Information and communication	2	0	0	5.71%	0.00%	0.00%
Manufacturing	3	13	1	8.57%	32.50%	8.33%
Professional, scientific and technical activities	3	0	0	8.57%	0.00%	0.00%
Transportation and storage	11	7	0	31.43%	17.50%	0.00%
Water supply; sewerage, waste management and remediation activities	6	4	4	17.14%	10.00%	33.33%
Grand Total	**35**	**40**	**12**	**100.00%**	**100.00%**	**100.00%**

Table 2: Top 20 listed RSA companies as of 2021 by market caps as of 2021 and their possible match with the taxonomies

Ticker	Name	Possible match with taxonomy
PRX SJ Equity	Prosus NV	Not matched
BHP SJ Equity	BHP Group UK LTD	Not matched
ANH SJ Equity	Anheuser-Busch InBev SA/NV	Not matched
2251506D SJ Equity	Cie Financiere Richemont SA	Not matched
BTI SJ Equity	British American Tobacco PLC	Not matched
NPN SJ Equity	Naspers Ltd	Motion picture, video and television programme production, sound recording and music publishing activities
GLN SJ Equity	Glencore PLC	Not matched
AGL SJ Equity	Anglo American PLC	Manufacture of iron and steel
AMS SJ Equity	Anglo American Platinum Ltd	Manufacture of iron and steel
FSR SJ Equity	FirstRand Ltd	Non-life insurance: underwriting of climate-related perils
MTN SJ Equity	MTN Group Ltd	Data processing, hosting and related activities
VOD SJ Equity	Vodacom Group Ltd	Not matched
CPI SJ Equity	Capitec Bank Holdings Ltd	Not matched
SBK SJ Equity	Standard Bank Group Ltd	Non-life insurance: underwriting of climate-related perils
MNP SJ Equity	Mondi PLC	Not matched
IMP SJ Equity	Impala Platinum Holdings Ltd	Not matched
SOL SJ Equity	Sasol Ltd	Electricity generation from renewable non-fossil gaseous and liquid fuels
GFI SJ Equity	Gold Fields Ltd	Not matched
KIO SJ Equity	Kumba Iron Ore Ltd	Manufacture of iron and steel
SSW SJ Equity	Sibanye Stillwater Ltd	Not matched

Table 3: Climate change mitigation criteria full model

*Note: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. The dependent variables are the ambition levels of the RSA GFT against the EU Taxonomy (e.g. RSA GFT less ambitious than EU Taxonomy; RSA GFT similar to EU Taxonomy; RSA GFT more ambitious than EU Taxonomy)*

Independent variables	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**	**Model 7**	**Model 8**	**Model 9**	**Model 10**
EU equity holding of RSA companies	5.296	5.591	5.528	5.549	5.410	6.995*	1.123	0.599	-1.346	-4.448
	(4.086)	(4.082)	(3.956)	(3.633)	(3.380)	(3.580)	(3.479)	(3.539)	(6.405)	(7.132)
EU bond holding of RSA companies		0.545	0.516	1.273	0.946	1.042	1.795	1.819	1.981	1.939
		(0.818)	(0.819)	(0.920)	(1.010)	(1.075)	(1.310)	(1.324)	(1.271)	(1.259)
RSA stock exchange			-2.031	-5.572*	-5.244	-2.660	-6.591**	-8.565***	-8.704***	-7.794**
			(3.787)	(3.325)	(3.272)	(3.417)	(3.010)	(3.095)	(3.129)	(3.357)
EU stock exchange				3.662**	4.031**	4.312**	5.647***	6.112***	6.199***	5.274**
				(1.657)	(1.680)	(1.781)	(1.925)	(2.037)	(1.993)	(2.256)
RSA Gross Value Added by sectors					6.248	6.405	8.872	8.549	9.339	8.666
					(5.795)	(5.630)	(5.879)	(5.862)	(5.979)	(6.008)
EU Gross Value Added by sectors						-3.692**	-4.392**	-4.210**	-4.415**	-5.112***
						(1.664)	(1.877)	(1.865)	(1.801)	(1.823)
RSA export to EU							8.568***	8.793***	8.870***	8.045***
							(2.133)	(2.183)	(2.139)	(2.439)
EU VC in RSA companies								-2.745**	-2.551*	-2.182
								(1.338)	(1.316)	(1.369)
EU commercial banks underwriting financing deals for RSA companies									3.051	3.773
									(3.845)	(4.419)
EU development banks underwriting financing deals for RSA companies										-8.362
										(7.379)
/cut1	-0.247*	-0.248*	-0.248*	-0.251*	-0.255*	-0.636***	-0.620***	-0.611***	-0.632***	-0.699***
	(0.136)	(0.137)	(0.137)	(0.137)	(0.139)	(0.229)	(0.236)	(0.234)	(0.234)	(0.240)
/cut2	1.095***	1.098***	1.099***	1.135***	1.146***	0.828***	0.890***	0.899***	0.891***	0.836***
	(0.172)	(0.171)	(0.171)	(0.177)	(0.174)	(0.248)	(0.253)	(0.252)	(0.253)	(0.254)
Observations	87	87	87	87	87	87	87	87	87	87

Table 4: Climate change mitigation criteria with financing deals for bond-listed RSA companies' full model

*Note: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. The dependent variables are the ambition levels of the RSA GFT against the EU Taxonomy (e.g. RSA GFT less ambitious than EU Taxonomy; RSA GFT similar to EU Taxonomy; RSA GFT more ambitious than EU Taxonomy)*

Independent variables	**Model 11**	**Model 12**	**Model 13**	**Model 14**	**Model 15**	**Model 16**	**Model 17**	**Model 18**	**Model 19**	**Model 20**
EU equity holding of RSA companies	3.556*	3.871*	4.174*	4.812**	5.420**	6.344**	1.919	1.934	0.331	-3.089
	(1.972)	(2.068)	(2.156)	(2.307)	(2.382)	(2.901)	(3.063)	(3.077)	(4.681)	(3.409)
EU bond holding of RSA companies		0.538	0.508	1.286	0.942	1.023	1.790	1.812	2.213**	2.389**
		(0.813)	(0.814)	(0.929)	(1.019)	(1.089)	(1.315)	(1.330)	(1.125)	(1.133)
RSA stock exchange			-2.383	-5.970*	-5.665*	-3.254	-6.694**	-8.624***	-9.464***	-9.343***
			(3.915)	(3.468)	(3.394)	(3.586)	(3.080)	(3.113)	(2.787)	(2.808)
EU stock exchange				3.728**	4.137**	4.434**	5.667***	6.121***	6.207***	6.541***
				(1.671)	(1.696)	(1.801)	(1.912)	(2.016)	(1.918)	(1.938)
RSA Gross Value Added by sectors					6.797	7.097	9.036	8.670	7.939	8.565
					(5.864)	(5.677)	(5.847)	(5.835)	(5.587)	(5.653)
EU Gross Value Added by sectors						-3.621**	-4.386**	-4.207**	-4.682***	-5.117***
						(1.664)	(1.881)	(1.869)	(1.723)	(1.736)
RSA export to EU							8.456***	8.577***	8.734***	9.534***
							(2.104)	(2.135)	(2.015)	(1.956)
EU VC in RSA companies								-2.768**	-2.654**	-2.594**
								(1.305)	(1.319)	(1.321)
EU commercial banks underwriting financing deals for RSA companies									13.837	15.787
									(9.383)	(10.975)
EU development banks underwriting financing deals for RSA companies										-47.715***
										(2.918)
/cut1	-0.248*	-0.249*	-0.249*	-0.253*	-0.258*	-0.632***	-0.622***	-0.614***	-0.656***	-0.655***
	(0.136)	(0.137)	(0.137)	(0.137)	(0.139)	(0.228)	(0.236)	(0.234)	(0.232)	(0.235)
/cut2	1.092***	1.096***	1.098***	1.135***	1.147***	0.836***	0.890***	0.898***	0.869***	0.907***
	(0.170)	(0.169)	(0.168)	(0.176)	(0.173)	(0.248)	(0.253)	(0.253)	(0.253)	(0.253)
Observations	87	87	87	87	87	87	87	87	87	87

Table 5: Climate change mitigation criteria with financing deals for stock-listed RSA companies' full model

*Note: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. The dependent variables are the ambition levels of the RSA GFT against the EU Taxonomy (e.g. RSA GFT less ambitious than EU Taxonomy; RSA GFT similar to EU Taxonomy; RSA GFT more ambitious than EU Taxonomy)*

Independent variables	**Model 21**	**Model 22**	**Model 23**	**Model 24**	**Model 25**	**Model 26**	**Model 27**	**Model 28**	**Model 29**	**Model 30**
EU equity holding of RSA companies	3.218*	3.595**	3.621**	3.931**	4.242***	5.485***	0.596	0.216	-3.837	-3.605*
	(1.673)	(1.830)	(1.737)	(1.578)	(1.573)	(1.970)	(1.321)	(1.365)	(2.897)	(2.156)
EU bond holding of RSA companies		0.549	0.520	1.289	0.952	1.047	1.800	1.822	2.993***	1.029
		(0.818)	(0.819)	(0.923)	(1.011)	(1.074)	(1.310)	(1.324)	(1.013)	(1.338)
RSA stock exchange			-2.131	-5.667*	-5.336	-2.831	-6.649**	-8.609***	-12.104***	-4.115
			(3.857)	(3.374)	(3.307)	(3.481)	(3.034)	(3.087)	(2.899)	(11.743)
EU stock exchange				3.692**	4.079**	4.373**	5.666***	6.126***	6.320***	-13.947
				(1.657)	(1.684)	(1.786)	(1.913)	(2.021)	(1.825)	(10.449)
RSA Gross Value Added by sectors					6.562	6.815	8.949	8.588	6.912	-13.677
					(5.821)	(5.649)	(5.863)	(5.850)	(5.500)	(11.634)
EU Gross Value Added by sectors						-3.657**	-4.388**	-4.206**	-5.626***	-14.936***
						(1.657)	(1.875)	(1.864)	(1.639)	(4.777)
RSA export to EU							8.658***	8.861***	10.774***	-12.920
							(2.073)	(2.119)	(1.887)	(11.713)
EU VC in RSA companies								-2.760**	-2.625**	0.368
								(1.323)	(1.276)	(4.505)
EU commercial banks underwriting financing deals for RSA companies									23.661***	18.102**
									(8.303)	(7.762)
EU development banks underwriting financing deals for RSA companies										-177.828**
										(74.974)
/cut1	-0.247*	-0.249*	-0.249*	-0.252*	-0.256*	-0.634***	-0.619***	-0.611***	-0.739***	-1.494***
	(0.136)	(0.137)	(0.137)	(0.137)	(0.139)	(0.229)	(0.236)	(0.234)	(0.242)	(0.471)
/cut2	1.092***	1.095***	1.097***	1.133***	1.145***	0.830***	0.891***	0.900***	0.850***	0.147
	(0.171)	(0.169)	(0.169)	(0.176)	(0.173)	(0.248)	(0.253)	(0.252)	(0.257)	(0.471)
Observations	87	87	87	87	87	87	87	87	87	87

Table 6: Bond holdings: Difference-in-difference for bond holdings in eligible economic activities after the launch of RSA GFT

Difference-in-difference	Model 31
Eligible activities	0.039
	(0.357)
After RSA GFT launch	0.010
	(0.245)
After RSA GFT launch * Eligible activities	0.273***
	(0.103)
Constant	-0.012
	(0.069)
Investor FE	Y
Issuer controls	Y
Observations	4,109
R-squared	0.2548
Log-likelihood	-961.1

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Issuer controls include current credit ratings, assets-to-liabilities ratio, sector, and whether the issuer is listed as of 31 December 2021.

Table 7: Bond holdings: Difference-in-difference for bond holdings in eligible economic activities with at least the same ambition level as the EU Taxonomy (including same ambition and more ambitious levels) after the launch of RSA GFT

Difference-in-difference	Model 32
Same ambition and more ambitious activities	-0.024
	(0.038)
After RSA GFT launch	0.034**
	(0.013)
After RSA GFT launch * Same ambition and more ambitious activities	0.141
	(0.216)
Constant	0.075**
	(0.037)
Investor FE	Y
Issuer controls	Y
Observations	3,245
R-squared	0.2539
Log-likelihood	-742.5

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Issuer controls include current credit ratings, assets-to-liabilities ratio, sector, and whether the issuer is listed as of 31 December 2021.

Table 8: Equity holdings: Difference-in-difference for equity holdings in eligible economic activities after the launch of RSA GFT

Difference-in-difference	Model 33
Eligible activities	0.004***
	(0.001)
After RSA GFT launch	0.257***
	(0.006)
After RSA GFT launch * Eligible activities	-0.003
	(0.004)
Constant	0.052***
	(0.003)
Shareholder FE	Yes
Issuer controls	Yes
Observations	70,921
R-squared	0.7524
Log-likelihood	80743

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Issuer controls include market capitalisation, book-to-market value, leverage ratio, capital expenditure, property plant and equipment (PPE), and long-term growth.

Table 9: Equity holdings: Difference-in-difference for equity holdings in eligible economic activities with at least the same ambition level as the EU Taxonomy (including same ambition and more ambitious levels) after the launch of RSA GFT

Difference-in-difference	Model 34
Same ambition and more ambitious activities	0.008***
	(0.001)
After RSA GFT launch	0.276***
	(0.008)
After RSA GFT launch * Same ambition and more ambitious activities	-0.031***
	(0.007)
Constant	0.044***
	(0.005)
Shareholder FE	Yes
Issuer controls	Yes
Observations	36,596
R-squared	0.7802
Log-likelihood	41331

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Issuer controls include market capitalisation, book-to-market value, leverage ratio, capital expenditure, property plant and equipment (PPE), and long-term growth.

Table 10: Syndicated loans: Difference-in-difference for syndicated loans in eligible economic activities after the launch of RSA GFT

Difference-in-difference	Model 35
Eligible activities	-0.244***
	(0.038)
After RSA GFT launch	-0.052***
	(0.008)
After RSA GFT launch * Eligible activities	0.062***
	(0.009)
Constant	0.137***
	(0.021)
Loan arranger FE	Yes
Issuer controls	Yes
Observations	562
R-squared	0.9344
Log-likelihood	1151

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Issuer controls include current credit ratings, assets-to-liabilities ratio, sector, and whether the issuer is listed as of 31 December 2021.

Table 11: Syndicated loans: Difference-in-difference for syndicated loans in in eligible economic activities with at least the same ambition level as the EU Taxonomy (including same ambition and more ambitious levels) after the launch of RSA GFT.

Difference-in-difference	Model 36
Same ambition and more ambitious activities	0.173***
	(0.037)
After RSA GFT launch	0.012***
	(0.002)
After RSA GFT launch * Same ambition and more ambitious activities	-0.317***
	(0.023)
Constant	0.181***
	(0.008)
Loan arranger FE	Yes
Issuer controls	Yes
Observations	410
R-squared	0.9749
Log-likelihood	1075

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Issuer controls include current credit ratings, assets-to-liabilities ratio, sector, and whether the issuer is listed as of 31 December 2021.

Table 12: Commodity exports: Difference-in-difference for RSA exports to the EU in eligible economic activities after the launch of RSA GFT

Difference-in-difference	Model 37
Eligible activities	1.414***
	(0.027)
After RSA GFT launch	-0.074***
	(0.013)
After RSA GFT launch * Eligible activities	0.077**
	(0.037)
Constant	11.207***
	(0.010)
Country FE	Yes
Observations	256,694
R-squared	0.1777
Log-likelihood	-660211

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 13: Commodity exports: Difference-in-difference for RSA exports to the EU in in eligible economic activities with at least the same ambition level as the EU Taxonomy (including same ambition and more ambitious levels) after the launch of RSA GFT.

Difference-in-difference	Model 38
Same ambition and more ambitious activities	-0.805***
	(0.052)
After RSA GFT launch	0.217***
	(0.064)
After RSA GFT launch * Same ambition activities	-0.207***
	(0.071)
Constant	13.118***
	(0.047)
Country FE	Yes
Observations	33,589
R-squared	0.449
Log-likelihood	-77797

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Online Appendices

Appendix OA.1: EU Taxonomy Development

The EU's journey toward sustainable finance classification began in 2016 with a High-Level Expert Group of 20 specialists from various sectors. Their work informed the European Commission's March 2018 "Action Plan: Financing Sustainable Growth," which prioritized creating a standardized classification system (taxonomy) for sustainable activities. The cornerstone EU Taxonomy Regulation took effect in July 2020, establishing six key environmental objectives:

- Climate change mitigation
- Climate change adaptation
- Sustainable use/protection of water and marine resources
- Transition to circular economy
- Pollution prevention/control
- Protection/restoration of biodiversity and ecosystems

For an activity to qualify as environmentally sustainable, it must:

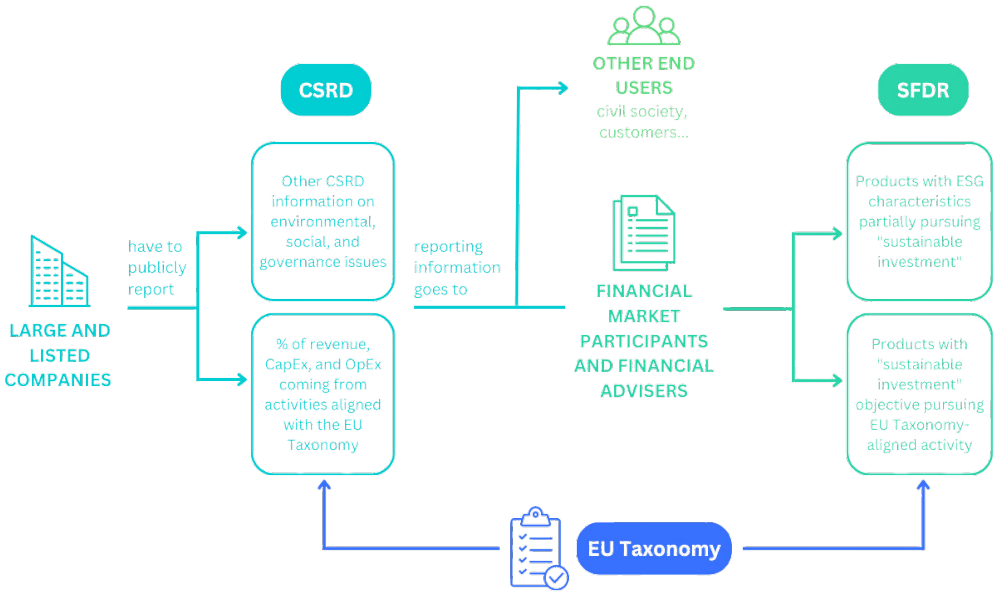
- Substantially contribute to at least one environmental objective
- Avoid significant harm to any objective
- Meet minimum safeguards
- Comply with technical screening criteria

To develop these technical criteria, the Commission formed a 35-member Technical Expert Group (TEG), followed by the permanent Platform on Sustainable Finance in 2020. The implementation has progressed through several key Delegated Acts:

- December 2021: First Act defining criteria for climate objectives (effective January 2022)
- July 2022: Complementary Act including specific nuclear and gas activities (effective January 2023)
- December 2021: Article 8 supplementary Act on disclosure requirements (effective January 2022)

- June 2023 Environmental Delegated Act, which extends the Taxonomy across all six environmental objectives.

The EU taxonomy is linked with other pieces of legislation which operationalise the use of the Taxonomy technical screening criteria and the disclosure of CAPEX, OPEX and REVENUE metrics for each of the economic activities which fall under the taxonomy.



Appendix OA.2: RSA GFT Working Group members (Source: National Treasury (2022), “Development process for the South African Green Finance Taxonomy”)

Organisation	Classification	Details
ABSA Bank	Financial market participant	Multinational banking and financial services company
Association for Savings and Investment South Africa (ASISA)	Financial market participant	Representative of the savings, investment and insurance industry
Banking Association South Africa (BASA)	Financial market participant	The national association of domestic and international banks operating in South Africa
Batseta (Council of Retirement Funds for South Africa)	Financial market participant	Focusing on the interests of principal officers, trustees and fund fiduciaries within the retirement industry
BNP Paribas	Financial market participant	Multinational banking and financial services company
Department of Planning, Monitoring and Evaluation (DPME)	Government agency	Leader and catalyst in achieving national development outcomes and impact in society
Department of Forestry, Fisheries and the Environment (DFFE)	Government agency	Responsible for protecting, conserving and improving the South African environment and natural resources
Development Bank of Southern Africa (DBSA)	Development agency	A development finance institution with the mandate to promote economic growth as well as regional integration for sustainable development projects and programmes in South Africa, SADC and the wider Sub-Saharan Africa
Financial Sector Conduct Authority (FSCA)	Financial authority	Financial institutions market conduct regulator and a successor agency to the Financial Services Board
FirstRand Bank	Financial market participant	A financial services provider in South Africa
Industrial Development Corporation of South Africa (IDC)	Development agency	A national development finance institution providing funding aimed at enhancing and growing South Africa’s industrial capabilities and, by extension, the rest of the African continent.
International Finance Corporation (IFC)	Development agency	An international financial institution promoting private-sector development in less developed countries
Johannesburg Stock Exchange (JSE)	Financial market participant	The largest stock exchange in South Africa
Old Mutual	Financial market participant	A financial services provider in South Africa
South African Reserve Bank Prudential Authority (PA)	Financial authority	The SARB has a statutory mandate to enhance and protect financial stability in South Africa.
South African National Treasury	Financial authority	The Treasury manages national economic policy, prepares the South African government's annual budget and manages the government's finances
Standard Bank	Financial market participant	A financial services provider in South Africa

Appendix OA.3: Detailed methodology with examples of arriving at the dependent variable

- **Incomparable**: this category applies to criteria for the Agriculture, forestry and fishing sectors While the RSA GFT follows the Climate Bonds Initiative's Forestry and Land Conservation & Restoration Criteria and South African Sustainable Forest Development Policy, the EU taxonomy refers to European standards.
- **Similar**: both taxonomies have a similar number of requirements and thresholds:
    - Reference to local laws or regulation: We classify the two criteria as similar for economic activities with criteria that have similar or identical overall criteria and thresholds with reference to respective local laws. An assessment of the details of respective laws and regulations applicable to South Africa and the EU is beyond the scope of this study.
    - Reference to international standards and industry standards: For economic activities with criteria that have identical requirements and thresholds with reference to international standards or industry standards, we then specifically compare them, and if they are similar, we classify the two criteria as similar.
- **More ambitious and/or more detailed**: the RSA GFT's criteria are more ambitious and/or more detailed, as demonstrated by a higher number of more detailed requirements and/or higher thresholds.
    - Reference to local laws or regulation: For economic activities in the RSA GFT with criteria that have a higher number of requirements we classify the RSA GFT criteria as more ambitious. An assessment of the details of respective laws and regulations applicable to South Africa and the EU is beyond the scope of this report.
    - Reference to international standards and industry standards: For economic activities with criteria that have a higher number, more detailed requirements, or higher thresholds, we classify the RSA GFT criteria as more ambitious.

- **Less ambitious and/or less detailed**: the SA GFT's criteria are less ambitious and/or less detailed as demonstrated by fewer or less detailed requirements and/or lower thresholds.
    - Reference to local laws or regulation: For economic activities in the RSA GFT with fewer requirements, we classify the RSA GFT criteria as less ambitious. An assessment of the details of respective laws and regulations applicable to South Africa and the EU is beyond the scope of this report.

Reference to international standards and industry standards: For economic activities with criteria that have a lower number or less detailed requirements or lower thresholds, we classify the RSA GFT criteria to be less ambitious and/or less detailed.

Appendix OA.4: The number of economic activities contributing to climate change mitigation by sector

Sector in the EU Taxonomy	**Number of economic activities**	**Sector in the SA RGFT**	**Number of economic activities**
Forestry	4	Agriculture, forestry, and fisheries	1
Manufacturing	17	Industry	9
Energy	25	Energy	12
Water supply, sewerage, waste management and remediation	12	Water and waste	12
Transport	17	Transportation	4
Construction and real estate	7	Construction	4
Information and communication	2	ICT	2
Environmental protection and restoration activities	1		
Professional, scientific and technical activities	3		

Appendix OA.5: Variables' description and source

No.	Variable	Variable longer name	Description	Source
1	EU equities	Equity holdings of EU investors as of 31 December 2021 in RSA companies	Equity holdings of EU investors in RSA companies over Equity holdings of world investors in RSA companies	Bloomberg Terminal
2	EU bonds	Bond holdings of EU investors as of 31 December 2021 in RSA companies	Bond holdings of EU investors in RSA companies over Bond holdings of world investors in RSA companies	Bloomberg Terminal
3	RSA stock exchange	Proportion of sector/ activity of listed companies in RSA as of 31 December 2021 in total market cap	Johannesburg stock exchange by sector as of 31 December 2022	iShares MSCI
4	EU stock exchange	Proportion of sector/ activity of listed companies in EU as of 31 December 2021 in total market cap	Eurostoxx 600 value by sector as of 31 December 2022	iShares MSCI
5	RSA GVA	Gross Value Added (GVA) proportions by sector in RSA (5-year average, from 2016 to 2020)	GVA proportions by sector in RSA	MarketLine
6	EU GVA	GVA proportions by sector in EU (5-year average, from 2016 to 2020)	GVA proportions by sector in EU	MarketLine
7	EU VC in RSA companies	Venture capital by EU investors in RSA companies by sector/ activity (average from 2000 to 2021)	Venture capital by EU investors in RSA companies by sector/ activity over Venture capital by world investors in RSA companies by sector/ activity	Preqin
8	RSA export to EU	Commodity exports of RSA to the EU (5 economies – Germany, France, Spain, Italy, & the Netherlands, 5-year average, from 2016 to 2020)	Commodity exports of RSA to the EU over commodity exports of RSA to world	UN Comtrade
9	EU banks underwriting financing deals for RSA companies	EU investment bank underwrite bonds /equities/ syndicated loans deals to RSA companies (5-year average, from 2016 to 2020)	Bonds underwritten by EU banks for RSA companies over bonds underwritten by all banks for RSA companies	Dealogic
10	EU development banks underwriting financing deals for RSA companies	EU development bank underwrite bonds /equities/ syndicated loans deals to RSA companies (5-year average, from 2016 to 2020)	Equities underwritten by EU banks for RSA companies over equities underwritten by all banks for RSA companies (5-year average, from 2016 to 2020)	Dealogic

Appendix OA.6: RSA export to the EU

Activity	Trade volume of RSA to EU as proportion of that to the world (%)
Manufacture of hydrogen	28.63%
Manufacture of carbon black	16.29%
Manufacture of aluminium	13.10%
Manufacture of iron and steel	12.77%
Manufacture of cement	11.99%
Manufacture of plastics in primary form	5.26%
Manufacture of organic basic chemicals	3.35%
Manufacture of batteries	1.40%
Manufacture of soda ash	0.75%
Manufacture of nitric acid	0.05%

Appendix OA.7: Top 10 EU commercial banks financing RSA companies (from 2016 to 2020)

No.	Bank Parent	Bank Parent Nationality	Total financing amount (USD)
1	Deutsche Bank	Germany	7,390,841,671
2	UniCredit	Italy	6,697,033,058
3	Credit Agricole CIB	France	4,325,077,480
4	BNP Paribas	France	3,222,117,201
5	SG Corporate & Investment Banking	France	1,598,533,061
6	Commerzbank Group	Germany	1,572,939,335
7	Banco BPM SpA	Italy	1,495,686,409
8	Erste Group Bank AG	Austria	1,131,735,367
9	BBVA	Spain	1,084,254,097
10	Intesa Sanpaolo SpA	Italy	982,725,584

Appendix OA.8: EU development banks financing RSA companies (from 2016 to 2020)

No.	Bank Parent	Bank Parent Nationality	Total financing amount (USD)
1	KfW	Germany	321,200,000
2	Nederlandse Financierings-Maatschappij voor Ontwikkelingslanden NV - FMO	Netherlands	42,566,667
3	Agence Francaise de Developpement - AFD	France	8,400,000