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Financial system interactions with ecosystem tipping points: evidence from the Brazilian Amazon and Indonesian peatlands

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Abstract

Large-scale ecosystem breakdown poses systemic macroeconomic and financial risks due to the loss of key ecosystem services, including carbon sequestration, upon which a great deal of economic activity relies. However, there has been little empirical work identifying the financial flows, as opposed to point-in-time measurements of financial exposure, that support activity associated with such ecosystem degradation. In this paper, we examine financial flows associated with two ecosystems – the Brazilian Amazon rainforest and tropical peatlands in Indonesia – where breaching ecosystem 'tipping points' could have systemic and irreversible impacts.

We use supply chain data to identify 39 companies linked to significant land use change and degradation in these ecosystems and connect this to a newly constructed granular dataset of financial flows covering lending and capital markets (equity and debt issuances) activities over the past decade. Flows to these companies were facilitated by a relatively concentrated group of commercial and investment banks, presenting a possible intervention point for influencing sustainability transitions. In the case of the Brazilian Amazon, flows were headquartered mainly in Global North financial hubs. For Indonesia, by contrast, most flows were domestically based or from the surrounding region.

To assess the potential impact of regulatory restrictions on these flows through changes to the cost or availability of financial capital, we undertook an initial exploration of the financial vulnerability of the larger companies in our sample and found significant heterogeneity. Whilst targeting financial flows could be impactful for some companies, such as those in the Brazilian beef sector, others have comparatively high retained earnings and low debt burdens, which may insulate them from finance-based measures to reduce their environmental impacts, including (macro)prudential regulations. This latter case, combined with the challenges of connecting a globalised financial system to on-the-ground impacts through networks of multinationals and their subsidiaries, suggests that (global) policy coordination across financial, fiscal and environmental policy spheres will be needed to decrease harmful economic pressures on ecosystems with tipping points.

Keywords: financial markets and the macroeconomy; central banks; climate change; biodiversity loss; tipping points; land use; commodity markets; capital and ownership structure; sustainable finance; government policy and regulation

JEL Codes: E44, E58, G18, G32, Q15, Q54, Q57

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1. Introduction

Human activity is increasing the likelihood of "tipping points" being passed in the Earth system – that is, thresholds beyond which a small additional perturbation triggers non-linear changes that qualitatively alter the state of an environmental system, powered by self-amplifying feedbacks (Lenton, 2013; Armstrong McKay et al., 2022; Lenton et al., 2023; Willcock et al., 2023). Passing these thresholds would rapidly undermine the planet's resilience and the self-reinforcing nature of the changes would push trajectories of climate change and nature loss beyond our control (Armstrong McKay et al., 2022). In particular, ecosystem tipping points (ETPs) will permanently alter the biodiversity of some of the world's critical natural systems and compromise the ecosystem services they provide to society (Mace et al., 2012; Marsden et al., 2024).[1] This includes destabilising some of the world's largest natural carbon sinks, which will accelerate global climate change and increase the risk of further tipping points (Parmesan et al., 2022; Ripple et al., 2023).

Such transitions clearly have implications for economic and financial stability, since human activity depends upon and is embedded within nature (Díaz et al., 2015; Dasgupta, 2021). As a result, tipping points in ecosystems have attracted the attention of economic and financial policymakers such as central banks and ministries of finance (Power et al., 2022; Lagarde, 2024; NGFS, 2024), as well as market participants (TNFD, 2023), in recent years.

The Amazon rainforest and Indonesian tropical peatlands are two pressing examples of ecosystems that may be subject to tipping dynamics. Forest resilience in the Amazon may be on a "critical slowing down" trend, typical of systems approaching a tipping threshold (Boulton et al., 2022). Large parts of the Amazon could experience mass dieback to a degraded forest, open-canopy state or non-forested savannah under water stress if feedback loops between rainfall, fire, and vegetation are disrupted, as these currently maintain the Amazon's substantial tree cover (Lovejoy and Nobre, 2018; Flores et al., 2024). These degraded states facilitate repeated wildfires (Hirota et al., 2021), interfere with the system's hydrological cycle (Lima et al., 2014; Zemp et al., 2017; Staal et al., 2020) and intensify regional drying (Parry et al., 2022; Cano et al., 2022) – all feedback effects that prevent the return of tree cover, meaning that changes are highly likely to be permanent.

Similarly, non-linear feedbacks across a range of scales currently stabilise tropical peatlands, primarily through high water levels (Swindles et al., 2012; Rocha et al., 2015; Evers et al., 2017). Draining water levels past a critical threshold results in rapid, irreversible drying that causes peat decomposition on scales much greater than when the ecosystems are left intact (Wösten et al., 2008; Page and Baird, 2016; Baird et al., 2017). Efforts to reverse these changes through re-wetting peatlands are likely to prove insufficient, since aspects of ecosystem functioning such as carbon storage and biodiversity could take centuries to recover (Hapsari et al., 2018; UNEP, 2021).

The crossing of tipping points in the Brazilian Amazon and remaining peatlands in Indonesia must be avoided, since both ecosystems provide locally, regionally, and globally important ecosystem

1 For a detailed overview of how ecosystem tipping points could translate into economic and financial risks, see Marsden et al. (2024).

services, including the natural carbon sequestration equivalent to over 20 years of CO2 emissions based on current rates (Lenton et al., 2023; Marsden et al., 2024) and the modulation of regional climates, including rainfall patterns (Taufik et al., 2020; Wang-Erlandsson et al., 2022; Liu et al., 2023).

The collapse of the Amazon rainforest and Indonesian tropical peatlands would be globally consequential for the risks that societies and economies face from the physical effects of climate change and nature loss. Crossing an Amazon tipping point could create economic losses of US$256.6 billion in cumulative GDP by 2050 in Latin American countries (Banerjee et al., 2022), with other estimates suggesting that US$1–3.6 trillion could be lost based on 2018 net present value (Lapola et al., 2018). The short-term socioeconomic costs of the 2015 peat fires for Indonesia alone were an estimated US$16.1 billion (World Bank Group, 2016) while the largest Indonesian fires between 2004 and 2015 caused US$93.9 billion in economic losses (Kiely et al., 2021). Negative economic consequences are likely to be much greater than expected once cascading and feedback effects are taken into account (Marsden et al., 2024), and since substitution of key ecosystem services through trade or technology is highly unlikely for nature degradation on this scale (Godin et al., 2022).

While both ecosystems are under pressure from climate change (Lovejoy and Nobre, 2019; Loisel et al., 2021), land use dynamics are an equal, if not more pressing, threat. In the Amazon, land use change through deforestation and forest degradation interferes with the positive feedback between rainfall and forest tree cover, increasing the likelihood of self-reinforcing forest loss (Zemp et al., 2017). In the Indonesian peatlands, conversion of land for agricultural purposes involves drainage and deforestation of overlying vegetation, both of which leave the peatland initially intact but highly vulnerable to fire and runaway decomposition (Girkin et al., 2022). It is not just new deforestation and conversion but any continued industrial agriculture plantations on peatlands that threaten their collapse and must be phased out (Wijedasa et al., 2017; Afriyanti et al., 2019; Conservation Economics Lab et al., 2023). In the Brazilian Amazon, cattle production for beef is the major direct driver of deforestation, followed by soy production (Zalles et al., 2019; Song et al., 2021; Berenguer et al., 2021; Haddad et al., 2024). Palm oil and pulp wood (to produce pulp and paper) plantations have been the primary drivers of deforestation in Indonesia and continue to expand on peatlands (Miettinen et al., 2016; Austin et al., 2019; Gaveau et al., 2022; Page et al., 2022). Deforestation rates have declined significantly in both Brazil and Indonesia in recent years after concerted regulatory and voluntary efforts (Mikaela et al., 2024; Butler, 2024). However levels of deforestation and plantation agriculture, respectively, still remain too high and threaten ecosystem resilience.

A plethora of solutions have been proposed to address the complex policy challenge of tropical land use change and degradation, targeting both proximate or direct drivers, to indirect or “distal” drivers on both the supply and demand-side (Geist and Lambin, 2002; Nepstad et al., 2014; Chen et al., 2019; Bastos Lima et al., 2021; Garrett et al., 2024). Some authors identify finance as having a potential indirect influence on land use change dynamics through the provision of credit and financial services (Richards and Arima, 2018), while others suggest that potentially harmful financial norms and incentives may be imported into business decisions in land-intensive

sectors (Clapp and Isakson, 2018; Mechiche-Alami et al., 2019; Kedward and Ryan-Collins, 2022). Financial actors and related policy measures have been suggested as "leverage points" (Jouffray et al., 2019; Dordi et al., 2023), "sensitive intervention points" (Farmer et al., 2019) or "positive tipping points" (Lenton et al., 2022) to drive a rapid shift to more sustainable activities in extractive sectors. To this end, there have been calls for further research on the role of finance in sustainability transitions (Naidoo, 2020; Steffen and Schmidt, 2021), as well as the inclusion of financial institutions in due diligence regulation targeted at deforestation-free supply chains (Global Witness, 2024; Greenpeace International et al., 2024).

However, studies that identify potentially influential financial actors in sectors impacting the environment have almost entirely focused on equity holdings at a certain point in time (Galaz et al., 2018b; Jouffray et al., 2019; Dordi et al., 2022; Dordi et al., 2023; Galaz et al., 2023). This provides important empirical insights. However, external financial flows, particularly debt, are critical to sustaining and extending corporate activities over time (Corbett and Jenkinson, 1997). Galaz et al. (2018b) provided a brief exploration of how financial influence may vary between asset classes, but this merits further consideration given that interactions between the corporate and financial sectors varies between sectors and over time (Baines and Hager, 2022; Braun, 2022).

These questions are also relevant to research and prudential policy discussions regarding how financial actors should identify, quantify and disclose how they will be impacted by the physical effects of climate change and nature loss (environment-related physical risks), and the actions taken to address these (environment-related transition risks). Financial interactions with negative impacts in critical ecosystems are particularly relevant for assessing transition risks to financial institutions, since such companies will likely be the target of policies aimed at halting and reversing nature loss, such as recent deforestation-free supply chain regulations (Cesar de Oliveira et al., 2024). Even where the transition risk posed to individual firms is low, there is a case for macroprudential policymakers – who have a system-wide view of risks posed to the financial system - to manage such financial interactions in a precautionary manner, as they may contribute to the build-up of environment-related physical risks for the overall system (D'Orazio and Popoyan, 2019; Steele, 2020; Monnin, 2021; Chenet et al., 2021; ECB/ESRB, 2022).

The present paper represents a first attempt to map financial flows to actors most implicated in harmful land use change and degradation in the Brazilian Amazon and Indonesian peatlands. To do this, we use a novel combination of publicly available supply chain data and a newly constructed dataset of financial flows – covering lending and capital markets activities (equity and debt issuances) – between 2014 and 2023. Secondly, we use financial ratio analysis to provide an initial assessment of how influential changes to external financing conditions may be for these companies (via macroprudential policies, for example), which sheds light on the potential effectiveness of precautionary financial policy measures to reduce systemic environment-related risks by limiting financial interactions with firms negatively impacting ecosystems.

We find a concentrated group of 39 companies linked to significant land use land use change and degradation through supply chains in the Brazilian Amazon and Indonesian peatlands (more than 1 per cent of the total), which we term "ETP risk companies". These have a range

of business models, from diversified multinationals to focused domestic companies, with implications for the financial flows that we trace. Many, though not all, of these ETP risk companies interact with the global financial system and we trace the main geographies, types of finance, and institutions involved – showing a concentration in key financial institutions that mirrors that the oligopoly of the agricultural sector. Most financial flows for the Brazilian Amazon are facilitated by institutions headquartered in North America and Europe, whereas financial flows linked to companies impacting Indonesian peatlands were more regional in scope – dominated by Indonesian, Japanese, and Chinese financial institutions. For many of the most important financial institutions, financial flows to these companies are less than 1 per cent of their annual financial flows. Importantly, we note that even those companies that do interact with the financial sector may be less susceptible to changes in their external financing conditions due to strong financial positions.

We offer several contributions in terms of methodological approach, results and policy implications. We build on previous studies of nature–finance interactions, which have often focused on equity holdings, allowing us to analyse privately and state-owned firms in more detail (Galaz et al., 2018b; Galaz et al., 2023). Our novel dataset of financial flows across several asset classes can show influence over time, thus offering new insights on important geographies, institutions, and asset classes. By retaining a link to measures of land use change and degradation and using three different financial ratios to understand financial influence, we provide insights on the heterogeneity and complexity involved in linking the financial system to environmental impacts, including the challenges posed by an increasingly complex network of intermediaries.

Our analysis has several implications for policymakers. First, we show that financial interactions with companies linked to the Brazilian Amazon and Indonesian peatlands are significant and that appreciably different geographies emerge for financial flows compared to physical commodity flows. This supports the case that financial institutions should be included in deforestation-free supply chain regulations. Second, the flows identified in our analysis could be a source of environment-related transition risk for financial institutions and hence relevant to prudential policymakers, although the risks to individual institutions could be low. Third, these financial flows could inform international efforts to identify financial flows that may be misaligned with the goals of the Paris Agreement and Kunming-Montreal Global Biodiversity Framework (GBF), and could be targeted by macroprudential policymakers wanting to combat excessive lending to environmentally damaging activities that may contribute to the build-up of risks for the overall economy and financial system. Finally, our findings that some companies may be insulated from finance-based measures suggest a need for greater policy coordination, while the complexity of interactions poses challenges to disclosure-based models of financial governance of environment-related risks.

The rest of the paper is structured as follows. Section 2 reviews the empirical literature that explores the connection between finance and activities linked to nature loss. Section 3 details our data and research methods. Section 4 presents our most relevant results. Section 5 discusses the findings in the context of existing research and provides initial policy implications. Section 6 concludes.

2. Related literature

Several studies use various metrics to associate industry classifications with drivers of nature loss (such as land use and nutrient pollution). The Exploring Natural Capital Opportunities, Risks, and Exposure (ENCORE) framework, which associates sector classifications with impact drivers of ecosystem services decline (ENCORE Partners (Global Canopy, UNEP FI, and UNEP-WCMC), 2024) has been used to estimate global nature-negative private financial flows (UNEP, 2023) and evaluate exposure to sectors strongly impacting ecosystem services (a proxy for transition risks) in Malaysian (World Bank and Bank Negara Malaysia (BNM), 2022) and Hungarian (Boffo et al., 2024) banks' commercial loan portfolios, as well as the European Central Bank's corporate bond portfolio (Kedward et al., 2021). Similarly, the Global Biodiversity Score (GBS) methodology – which converts sector classifications first to environmental pressures, followed by impacts on biodiversity – has been used to estimate the biodiversity footprint (in spatial metrics) of French (Hadji-Lazaro et al., 2024), European (Ceglar et al., 2023) and Dutch (van Toor et al., 2020) financial institutions.

These sector-based studies give a useful but coarse overview of transition risks facing financial institutions since they usually consider global sector classifications without regard for location. They do not illustrate financial interactions with critical ecosystems such as the Brazilian Amazon or Indonesian peatlands to give an "ecosystem-based" view of nature-related risks (NGFS, 2024). As a result, such methodologies are likely too broad to identify financial activities that may be misaligned with global climate and nature targets since nature loss is highly location-specific (TNFD, 2023).

Other studies use spatial data or proxies to identify companies that operate, and potentially impact nature, in specific ecosystems. For example, researchers have shown that Brazilian (Calice et al., 2021), Dutch (van Toor et al., 2020), and Malaysian (World Bank and Bank Negara Malaysia (BNM), 2022) financial institutions were exposed to companies operating in areas of global nature importance such as (future) protected areas or Key Biodiversity Areas (KBAs), which could present transition risks to financial institutions if these ecosystems are subject to area-based conservation measures that prohibit certain forms of economic activity. Large-scale analyses of financial flows across multiple asset classes have been conducted using this company-specific approach (Global Witness, 2019; Forests & Finance, 2023; Elwin et al., 2023; Greenpeace International et al., 2024), but they have tended to focus on all companies involved in activities at risk of causing deforestation in certain countries, without linking this to land use change metrics for specific subnational ecosystems.

A handful of studies have applied this approach to study specific ecosystems in more detail. Galaz et al. (2018b) traced equity holdings in agriculture and forestry companies operating in the Amazon rainforest and boreal forests in Canada and Russia, both of which could be subject to tipping points. Similarly, Galaz et al. (2023) identified connections between global financial actors and companies linked to land use change in subnational regions with elevated risk of zoonotic disease emergence, including the Brazilian Amazon and Indonesia. In both studies, financial interactions are traced through equity holdings data. Stand.earth (2023), traced US$20 billion in

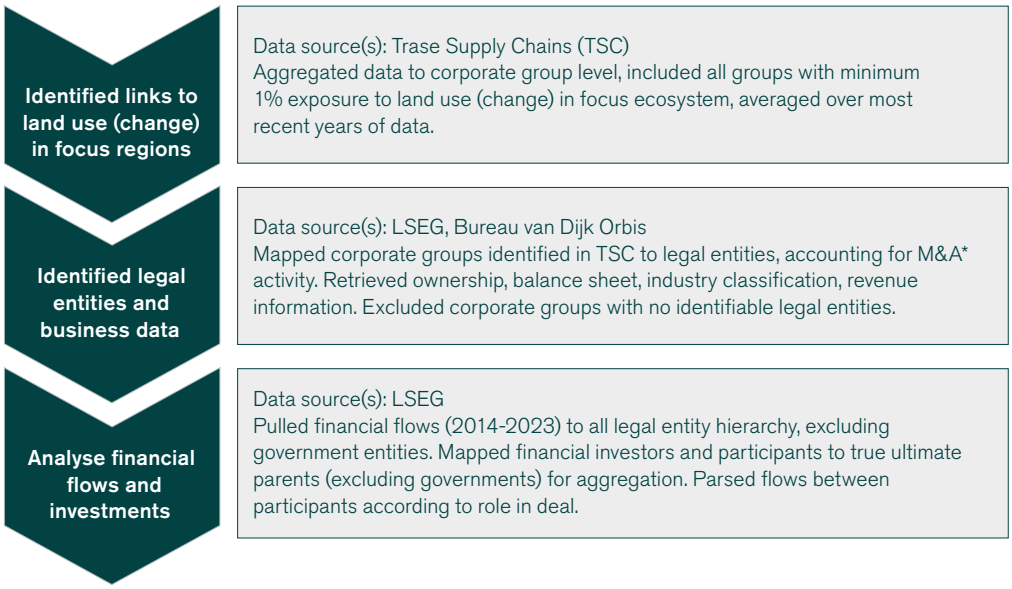
financial flows directly to oil and gas activities in the Amazon region between 2009 and 2023. However, no studies trace global financial flows to the more major deforestation drivers – beef and soy – linked specifically to the Brazilian Amazon, or to the peatlands in Indonesia.

In summary, a growing literature traces connections between parts of the financial system and negative impacts on nature. A company-specific approach is required to understand financial interactions with specific ecosystems such as the Amazon rainforest or Indonesian peatlands, as it allows for a more precise tracing of financial exposures and flows. Some studies have taken such an approach to identify financial interactions with companies in the Amazon rainforest and Indonesia as a whole, but these have either focused on equity holdings, not covered the most important deforestation drivers, or lacked the subnational focus needed to zoom in on our ecosystems of interest. Importantly, stock measures such as equity holdings represent exposures at a point in time, while financial flows represent new sources of finance that support a company to invest and expand its activities (Corbett and Jenkinson, 1997). Therefore, our analysis of financial flows, where we retain a link to land use change and degradation metrics in the Brazilian Amazon or Indonesian peatlands for each company, presents a novel contribution to this emerging field on nature-finance interactions.

3. Methodology and data

The key proximate pressures on the Brazilian Amazon and Indonesian peatlands relate to land use change and land use respectively, which – together with climate change – are increasing the risk of ETPs in both systems. We aimed to connect measures of this to individual companies or actors, to then trace financial flows. Figure 1 summarises the methodology, which we now describe in more detail.

Figure 1: Data and methodology for identifying ETP risk companies and tracing their financial flows.



3.1 Identifying companies linked to land use (change)

We used data from Trase Supply Chains (TSC), which links companies exporting beef and soy from Brazil (Lathuillière et al., 2022; zu Ermgassen et al., 2023), and wood pulp and palm oil from Indonesia (Trase, 2022; Benedict et al., 2023) to subnational regions of production and environmental metrics through their supply chains. By using export data, TSC largely identifies agricultural traders: midstream actors who play a key role in processing and distributing agricultural and forestry products. Despite not always being involved in on-the-ground land use dynamics, traders remain highly relevant to our research question as they are the common link that connects smaller-scale domestic producers (or "agents of deforestation" (Bastos Lima et al., 2021)) to global markets. Thus, their acceptance of commodities indirectly influences land use dynamics. This coordinating role is primarily concentrated in a handful of large corporations, which gives these actors outsized influence over global ecological transitions (Lyons-White and Knight, 2018; Folke et al., 2019; Grabs and Carodenuto, 2021; De Petrillo et al., 2023; Grabs et al., 2024). Moreover, some of these actors are already vertically integrated across production, processing and trade (Lambin et al., 2018), while traceability requirements intended to improve agricultural sustainability, such as the EUDR, are likely to further increase incentives for vertical coordination or even total vertical integration in large agrifood actors (Cotula, 2012; Lambin and Thorlakson, 2018).

For soy and beef in Brazil, we filtered TSC data to include only the Amazon biome and used a stock metric of embedded deforestation associated with physical commodity flows ("deforestation exposure"). For pulp wood and palm oil in Indonesia, we used TSC data that links physical commodity flows (tonnes) back to subnational regions of production and combined this with data on each crop's land use area (hectares) on Indonesian peatlands at the same level of regional granularity.[2] We apportioned this land use (change) between companies based on their relative proportion of sourced commodity flows for each subnational region. These commodity flows are allocated by TSC to companies based on a combination of disclosures and modelling. Values may differ from land use (change) areas disclosed by companies as under their direct ownership/monitoring due to this. Deforestation exposure is a stock metric of embedded land-use change, whereas plantation area on peatlands is a stock metric of land use. As such, we refer to these metrics collectively as "land use (change)" to reiterate that they are distinct concepts. These two land use (change) metrics were averaged over the three most recent years of data to account for volatility while using the most up-to-date information possible.[3] The exception was for Brazilian beef, where only two years of data were available. We did not incorporate company-specific sustainable commodity sourcing policies into our analysis, which may mitigate some of the risks of land use (change) in supply chains. In Section 5, we consider how limitations with TSC data may influence our findings. Appendix A1 explains our methodology in more detail.

2 This method used data from Gaveau et al. (2022) aggregated to subnational levels by TSC and provided to us for the purposes of this analysis.

3 2018–20 for Brazilian soy and Indonesian palm oil, 2020–22 for Indonesian wood pulp, and 2019–20 for Brazilian beef.

We aggregated land use (change) up to the corporate group level – parent companies mapped by TSC that own or control subsidiaries in the supply chain data – and identified those linked to a significant proportion of land use (change) as "ETP risk" companies, defined as a minimum of 1 per cent of the total (excluding domestic consumption) for each ecosystem/commodity. As TSC does not contain information such as unique identifiers, we then mapped these ETP risk companies to legal entities in LSEG, accounting for mergers. We retained TSC as the backbone of our data because this allowed us to preserve the link between land use and financial data and to cover conglomerates where legal entities were not connected by a single ultimate parent in LSEG. However, we note that there may be cases where companies dispute this hierarchy and this should be taken into account when interpreting our data.[4] We used LSEG to classify ETP risk companies according to their headquarters, listing status (private, state-owned, partially or fully listed); horizontal integration (focused or diversified) and geographic orientation (domestic or multinational). We were able to map all but one ETP risk company to at least one legal entity in LSEG.

3.2 Tracing financial flows

Financial institutions can interact with companies, including ETP risk companies, in primary and secondary markets. Financial stocks are holdings of equity and bond instruments in the secondary (traded) market that represent the ongoing exposure of financial institutions to ETP risk companies at a particular point in time but not new sources of finance. By contrast, financial flows in the primary market (our focus here) represent new external sources of finance that enable corporate activities over time. Companies primarily raise this finance via bank loans (provided either bilaterally or in syndicates) or by issuing new equity and debt instruments on public or private capital markets.

Here, we focused on the institutions, typically commercial and investment banks, that manage the transactions providing financial flows to ETP risk companies. The role of financial institutions, particularly banks, is different for lending versus capital markets issuance. For loans, commercial banks manage transactions, providing finance from their own balance sheets.[5] For capital markets activity, commercial and investment banks manage transactions but do not typically provide finance from their own balance sheets. Instead, they secure institutional investors to fund the deal but provide a backstop if the deal is undersubscribed. This is more of a "facilitating" role (PCAF, 2023). However, we include this activity together with lending in our analysis, since capital markets facilitation still represents a source of financial risk to banks and also plays a critical role in providing market access to companies through securitisation, underwriting and advisory services (Maio et al., 2023). Moreover, even loans do not necessarily remain on the balance sheet of managing banks, particularly if syndicated, which prevents a clear-cut distinction between the two (Haselmann and Wachtel, 2011; Cohen et al., 2021). This approach is in line

4 For example, TSC attributes pulp and paper company Toba Pulp Lestari (TPL) to the Royal Golden Eagle (RGE) conglomerate (Trase, 2021). However, RGE disputes that TPL is part of its corporate group and is instead a supplier associated with the group (RGE, 2022). We retain the link in our data to ensure consistency, but this should be considered when interpreting our data.

5 We termed these capital markets "issuance" and "facilitation" on the company side and managing financial institution side, respectively.

with similar studies of financial flows by the United Nations (UNEP, 2023) and recommendations by the ECB on banks' climate targets and disclosures (Maio et al., 2023).

We analysed overall financial flows to ETP risk companies by covering the entire corporate structure of legal entities identified in the first stage of our analysis. Since many companies operate across multiple business lines and regions, not all flows will be specifically directed towards activities associated with land use (change) in the regions we focus on. However, since financial capital is fungible, any external finance provided to one part of a business can, in principle, be transferred to elsewhere in the structure. Large corporate groups typically have well-developed internal capital markets that can be used to direct finance from more creditworthy subsidiaries towards those engaged in riskier behaviour that makes it difficult for them to access external finance directly (Casey, 2014). Ashwood et al. (2022) showed that this "internal-market-financing" is integral to the organisation of land investment by some corporations in the United States, although few other empirical studies exist for agricultural firms. Due to this behaviour, overall financial flows to an ETP risk company remain relevant for understanding how harmful business activities linked to the Brazilian Amazon and Indonesian peatlands are enabled. This "group-level" responsibility – where the activities of all subsidiaries and parents are taken into consideration when assessing any entity in a corporate group – has been suggested in a proposal to include financial institutions in the European Union Deforestation Rule (EUDR) since it better represents how corporate finance is structured and reflects such concerns over intra-company lending (Greenpeace International et al., 2024).

We used LSEG's Deals Business Intelligence Data (LSEG, 2024) to collect completed deals – lending and capital markets (equity and debt) issuances – between 1 January 2014 and 31 March 2024. Deal figures were provided in nominal United States Dollars (US$), with deals completed in other currencies converted by LSEG using spot exchange rates at close dates. This resulted in 1590 deals totalling US$681.6 billion (nominal). We excluded 422 deals (US$80.0bn) that were duplicates; a further 24 (US$27.3bn) with no managing institutions recorded; and the remaining 23 deals (US$8.2bn) recorded in 2024 due to incompleteness. This left 1121 deals totalling US$566.1 billion (nominal). We then grouped deals by month of financial close and deflated amounts to Jan 2014 US$ using the monthly US Consumer Price Index from LSEG to account for inflationary dynamics, leaving a final dataset totalling US$515.8 billion (in 2014 US$).

Because deals were typically managed by several institutions in a syndicate, we split amounts between institutions to create a granular issuer-tranche-participant dataset.[6] Where individual amounts were not correctly disclosed, we used a formula to allot amounts to institutions based on their role in the deal. Section A1 in the Appendix explains our methodology in more detail.

Financial flows were attributed to managing institutions' ultimate parent. LSEG deals data does not include the unique identifiers for these actors, preventing a straightforward mapping to ultimate owners. To solve this, it was necessary to match names into the main LSEG database to access other characteristics such as location of headquarters and industry classifications. We obtained matches for 99.2 per cent of institutions. Financial flows were then aggregated

6 "Issuer" refers to the company receiving finance, "tranche" refers to the portion of the deal, and "participant" refers to the institutions who arranged the deal and, in the case of lending, provide finance from their balance sheets.

according to the information characterising the ultimate parent. These data were not available for all institutions leading to a small number of flows attributed to unknown countries, regions, or industries. For a subset of the most implicated institutions, the top ten for each of the Brazilian Amazon and Indonesian peatlands, we compared financial flows to ETP risk companies to their overall flows for 2023 using LSEG data. We contacted the companies and financial institutions represented in our figures prior to publication and invited responses. Our analysis does not assess companies or financial institutions on their sustainability policies or ESG risk management approaches.

3.3 Understanding financial influence

Our dataset of financial flows can provide a sufficient, if not complete, overview of the main financial institutions, geographies, and types of finance important to ETP risk companies. Some aspects will illuminate potential points of influence, such as the presence of significant flows to begin with and whether they are concentrated within certain institutions or geographies. However, the extent to which financial interventions have a strong "pass through" to real economy factors such as corporate investment is complex, arising from many factors including company capital structure, the macroeconomic environment, and socio-economic effects like reputational risk (McConnell et al., 2022).

A key microeconomic factor is how dependent a company's capital formation is on external funds, with reduced internal financing capability linked to greater influence for external financial actors based on a threat of "exit" from the company (Braun, 2022). Moreover, since financial interventions are often price-based measures that may increase a company's overall cost of capital, sensitivity to changes in interest payments are also important. Clearly, these factors remain a strategic choice by companies and do not unilaterally constrain their behaviour. However, exploring them can provide an initial picture of how ETP risk companies' linkages to financial markets may confer influence to financial actors, and, as a result, to financial policy.

Galaz et al. (2018b) and Baines and Hager (2022) both used debt-to-capital ratios to assess how dependent some of the firms included in this study are on external finance. However, such ratios provide a generic overview of a firm's capital structure rather than its sensitivity to external finance (Schoenmaker and Schramade, 2023). We improve on these studies by calculating debt-to-asset ratios, which measure the relative amount of the company's assets that are provided through debt. We also explore retained earnings, which are a better indicator of internal financing capability (Ibid). Finally, we analyse interest coverage ratios, which indicate sensitivity to changes in cost-of-capital (Davidson, 2020). Given that the ETP risk companies were heterogeneous in their business models and geographic orientation, we compared firm results for the above metrics to a range of industry and global aggregates. All data were sourced from LSEG.

These balance sheet metrics can provide an indication of how a company's expansion and investment in physical assets is funded (Corbett and Jenkinson, 1997). However, alone they cannot indicate whether such physical investment translates into on-the-ground impacts such as

land use dynamics. This would require causal analysis that is beyond the scope of this paper, and is compounded by additional complexities since some of the companies we study are midstream actors whose interactions with the environment are mediated by further intermediaries. We consider the implications of this for our results in Section 5.

4. Results

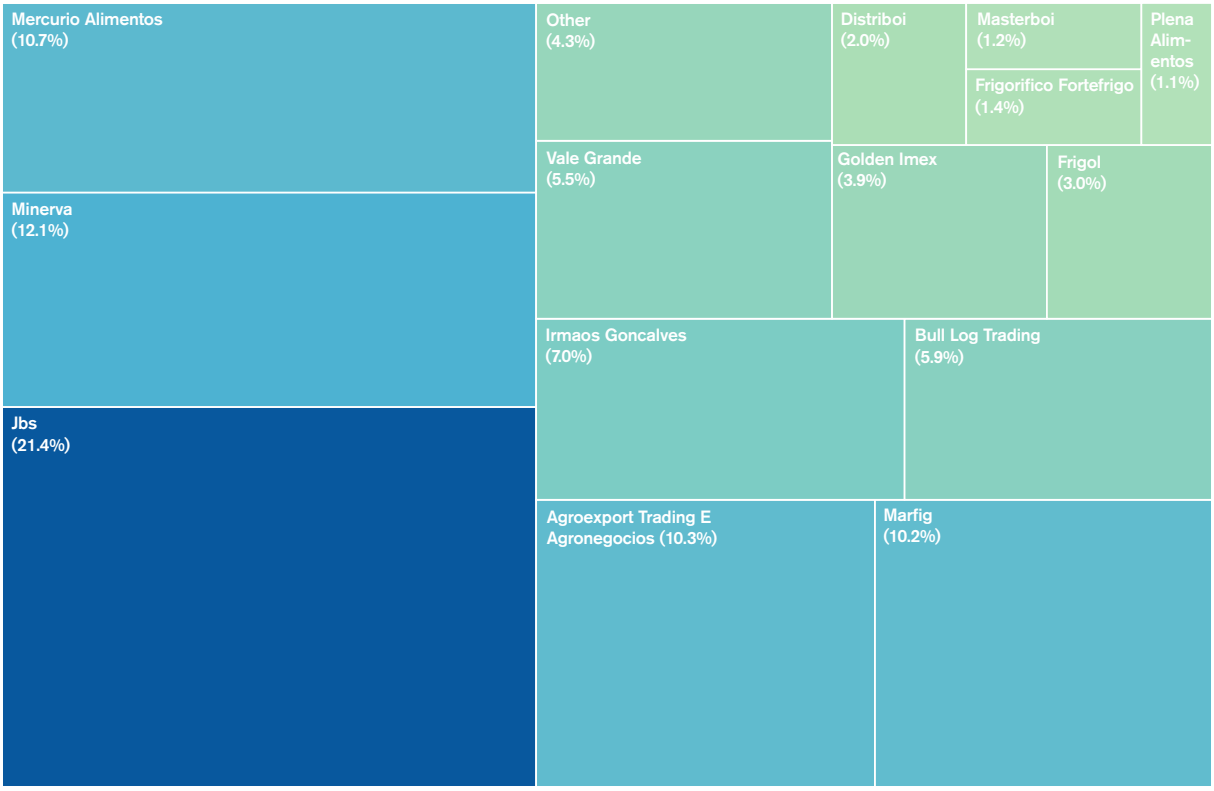
4.1 Companies linked to land use (change) in the Brazilian Amazon and Indonesian tropical peatlands

Our analysis of TSC data found that a relatively small number of ETP risk companies were exposed to most of the land use (change) in the Brazilian Amazon and Indonesian peatlands. We identified 39 "ETP risk companies" that were associated with a minimum of 1 per cent land use (change) for each commodity (beef, soy, palm oil or wood pulp) in the focus region (Figure 2, Figure 3). Collectively, these companies made up 94.6 per cent (0.26 Mha), 85.9 per cent (0.03 Mha), 88.7 per cent (1.10 Mha) and 87.2 per cent (0.89 Mha) of land use (change) associated with beef, soy, palm oil and wood pulp production destined for export, respectively.

Most of the ETP risk companies we identified were state-owned, private, or only partially listed. Just four ETP risk companies, all linked to Brazilian soy, were fully public and accounted for 49.0 per cent of associated land use (change) (Table 4, Appendix). Except for Brazilian beef, the ETP risk companies exposed to the most land use (change) were multinationals, which accounted for 75.2 per cent, 81.2 per cent and 87.2 per cent of the TSC data for Brazilian soy, Indonesian palm oil, and Indonesian wood pulp, respectively, but only 43.2 per cent for Brazilian beef. The most important companies for soy, palm oil, and wood pulp were diversified across multiple activities but all Brazilian beef companies were classified as focused companies. Therefore, ETP risk companies' geographies and business orientations differed qualitatively depending on the context, which, as shown in the next section, had implications for tracing financial flows.

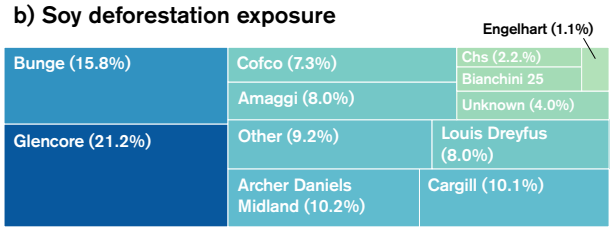
Figure 2: ETP risk companies at risk of exposure to land use change in the Brazilian Amazon through beef and soy supply chains and proportion of embedded deforestation. Those linked to less than 1 per cent of embedded deforestation labelled as "Other". Data from Trase Supply Chains analysed by the authors.

a) Beef deforestation exposure



Total: 275,884 hectares
(2019-20 mean, excluding domestic consumption)

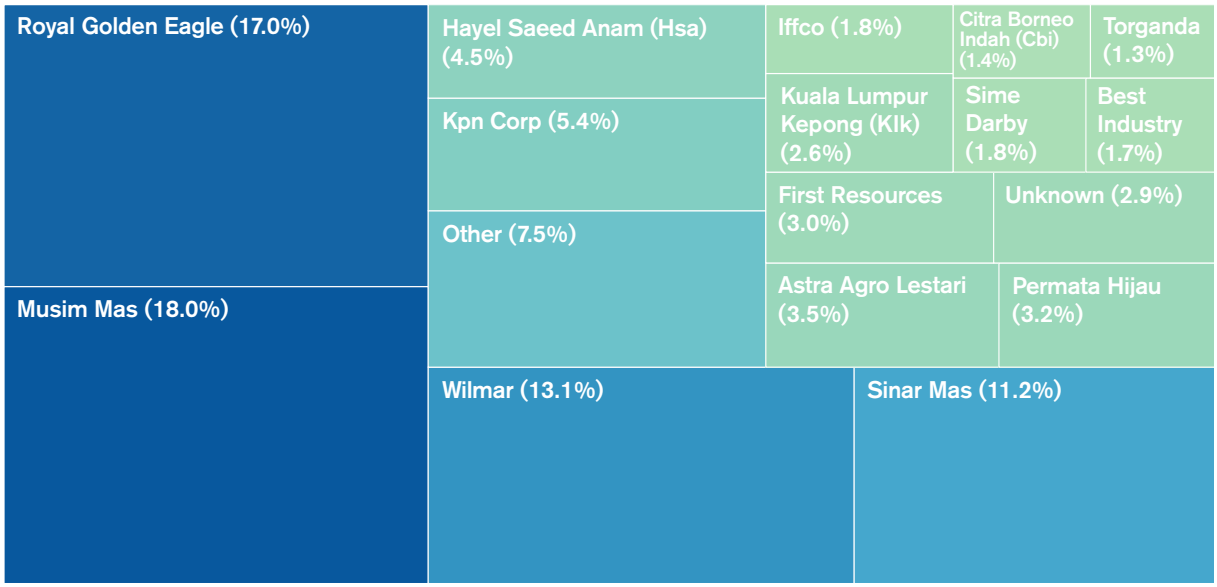
b) Soy deforestation exposure



Total: 39,142 hectares
(2018-20 mean, excluding domestic consumption)

Figure 3: ETP risk companies at risk of exposure to land use in Indonesian peatlands through palm oil and wood pulp supply chains and proportion of land use on peatlands. Those linked to less than 1 per cent of embedded land use labelled as "Other". Some companies operate across both sectors Data from Trase Supply Chains analysed by the authors..

a) Palm oil plantations on peatlands



Total: 1,221,076 hectares
(2018–20 mean, excluding domestic consumption)

b) Wood pulp plantations on peatlands

Total: 992,664 hectares
(2020–22 mean, excluding domestic consumption)

4.2 Financial flows

Of the 39 ETP risk companies identified, we traced financial flows to 24 companies and were unable to for the remaining 15. Those without traceable financial flows were all domestic, focused companies linked to Brazilian beef and Indonesian palm oil. The three companies linked to Indonesian palm oil represented 8.4 per cent (0.10 Mha) of palm oil plantations on peatlands in our data.[7] By contrast, the 12 companies linked to Brazilian beef accounted for 54.3 per cent (0.15 Mha) of Amazon cattle deforestation in our data.[8]

The mapped financial flows amounted to US $455.5 billion and US $60.2 billion for ETP risk companies in the Brazilian Amazon and Indonesian peatlands, respectively, between 2014 and 2023 (Table 1), adjusted to 2014 US dollars. Most financial flows were in the form of syndicated loans. However, capital markets activity – where the attributed financial institution facilitates the issuance of securities that are likely to remain off its own balance sheet, without providing its own financial capital – still made up 29.7 per cent and 36.8 per cent of financial flows to ETP risk companies in the Brazilian Amazon and Indonesian peatlands, respectively, over the study period, largely through bond issuances. Equity issuances were a relatively minor proportion of external financial flows to ETP risk companies compared to debt financing.

Table 1: Financial flows to ETP risk companies in the Brazilian Amazon and Indonesian peatlands between 2014 and 2023, adjusted to 2014 US dollars

1a) Brazilian Amazon: financial flows to ETP risk companies, 2014–2023.

Category	Total (2014 US$m)	Proportion
Overall	455,534	100.0%
Breakdown by asset class		
Syndicated loans	320,155	70.3%
Capital markets issuance	135,379	29.7%
Bond issuance	127,495	28.0%
Equity issuance	7,884	1.7%
Breakdown by commodity		
Soy	411,260	90.3%
Beef	44,274	9.7%

1b) Indonesian peatlands: financial flows to ETP risk companies, 2014–2023.

Category	Total (2014 US$m)	Proportion*
Overall	60,247	100.0%
Breakdown by asset class		
Syndicated loans	38,038	63.1%
Capital markets issuance	25,162	36.8%
Bond issuance	18,463	30.6%
Equity issuance	3,746	6.2%
Breakdown by commodity		
Palm oil	60,247	100.0%
Wood pulp	15,051	25.0%

* Figures sum to >100 per cent due to overlap between commodities

7 Best Industry, KPN Corp, and Torganda.

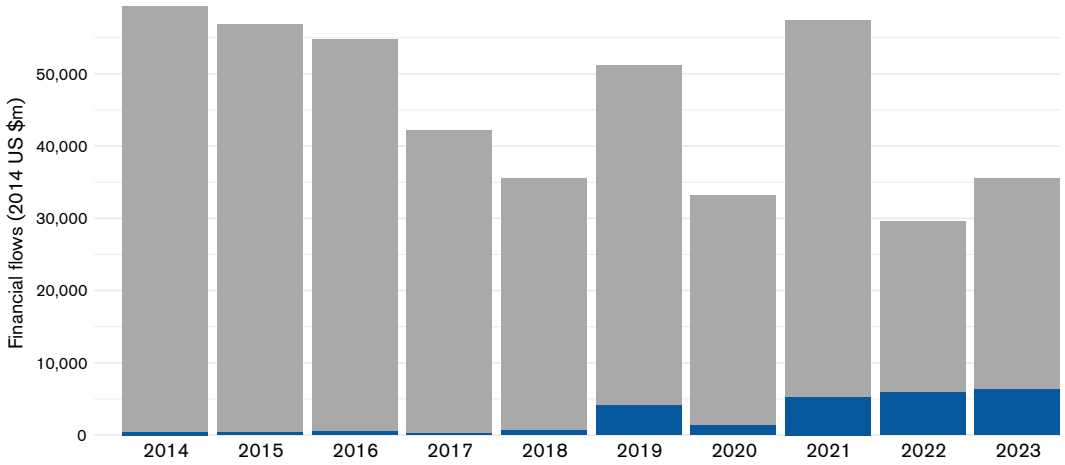
8 Agroexport Trading E Agronegocios, Bianchini, Bull Log Trading, Distriboi, Frigol, Frigorifico Fortefrigo, Golden Imex, Irmaos Goncalves, Masterboi, Mercurio Alimentos, Plena Alimentos, and Vale Grande.

Most finance provided to ETP risk companies had no restrictions placed on use-of-proceeds; 73.7 per cent and 66.9 per cent of financial flows were general corporate purpose finance for the Brazilian Amazon and Indonesian peatlands, respectively (Table 6, Appendix). In contrast, just 0.5 per cent of financial flows linked to Brazilian Amazon ETP risk companies were project finance (use-of-proceeds specified), with no project finance flows mapped for companies linked to the Indonesian peatlands.

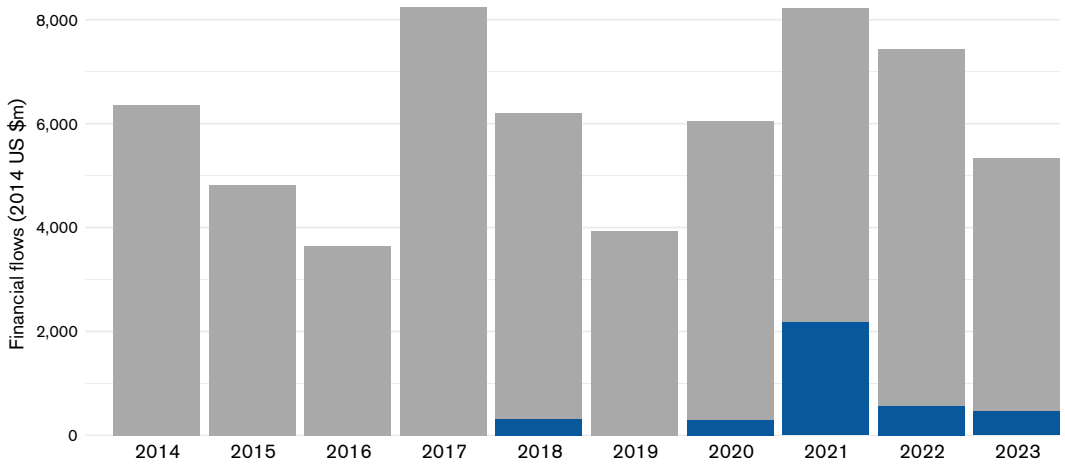
Financial flows tagged 'sustainable'[9] represented 5.5–6.3 per cent of the total between 2014 and 2023, increasing in importance over time (Figure 4). However, most of these sustainable financial flows were not strictly ringfenced; the majority were unrestricted, tagged as general corporate purpose or working capital instruments. Instruments where use-of-proceeds are typically ringfenced, such as green bonds, counted for only 0.2–1.2 per cent of the total (Table 7, Appendix).

Figure 4: Financial flows to ETP risk companies over time, with transactions tagged as "sustainable" shown in blue.

a) Companies linked to Brazilian Amazon



b) Companies linked to Indonesian peatlands



9 This encompasses explicitly labelled sustainable financial instruments such as green bonds and sustainability-linked financing, as well as general corporate purpose finance to companies included in LSEG's list of sustainable industry classifications.

The geography of institutions providing and facilitating financial flows to ETP risk companies differed substantially between the Brazilian Amazon and Indonesian peatlands. For the former, Institutions headquartered in Europe, North America, and Asia provided and facilitated 40.9 per cent, 29.0 per cent, and 21.4 per cent of flows, respectively (Figure 5). Brazilian headquartered institutions played only a limited role – 3.1 per cent of the total – and only 3.9 per cent of flows overall were attributed to Latin American institutions. All of the top five countries – the USA (22.7 per cent), UK (9.7 per cent), China (9.1 per cent), Japan (7.8 per cent), and France (7.7 per cent) – were in entirely different geographic regions to the Amazon biome (Figure 7). By contrast, financial flows to ETP risk companies linked to Indonesian peatlands had a much stronger domestic dimension – institutions headquartered in Asia facilitated 76.1 per cent of flows, with a further 16.9 per cent facilitated by UK institutions (Figure 6). Indonesia accounted for 17.5 per cent of financial flows and of the top five countries, three were in Asia (China – 14.0 per cent, Japan – 11.9 per cent, Singapore – 11.7 per cent), followed by the UK (9.7 per cent) (Figure 7). Geographic sources of finance varied substantially depending on the company (Table 5, Appendix).

Figure 5: Brazilian Amazon – financial flows between 2014 and 2023 to companies linked to deforestation, by region of headquarters of the institution providing or facilitating finance.

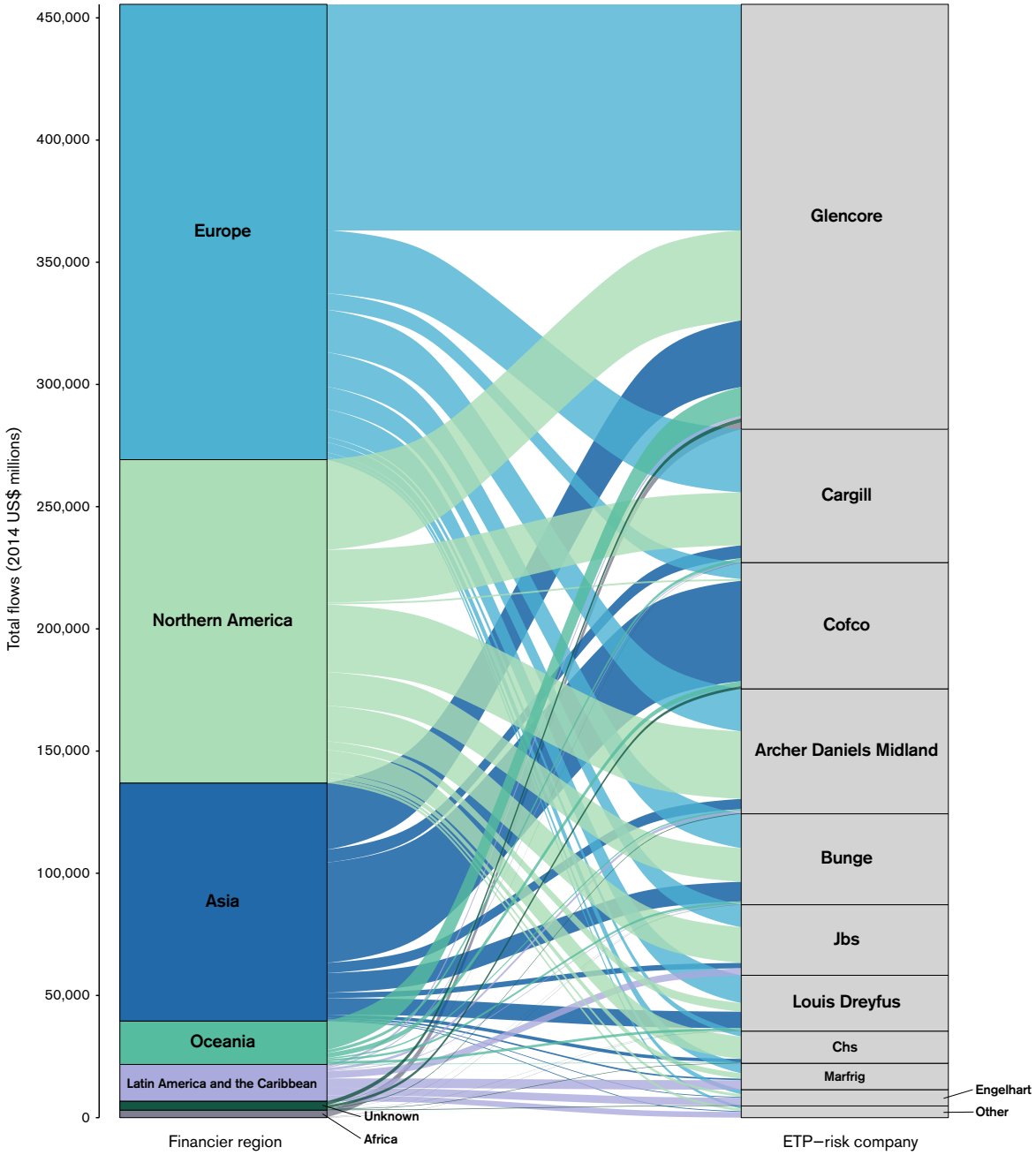


Figure 6: Indonesia peatlands - financial flows between 2014 and 2023 to companies linked to plantation agriculture on peatlands, by region of headquarters of the institution providing or facilitating finance.

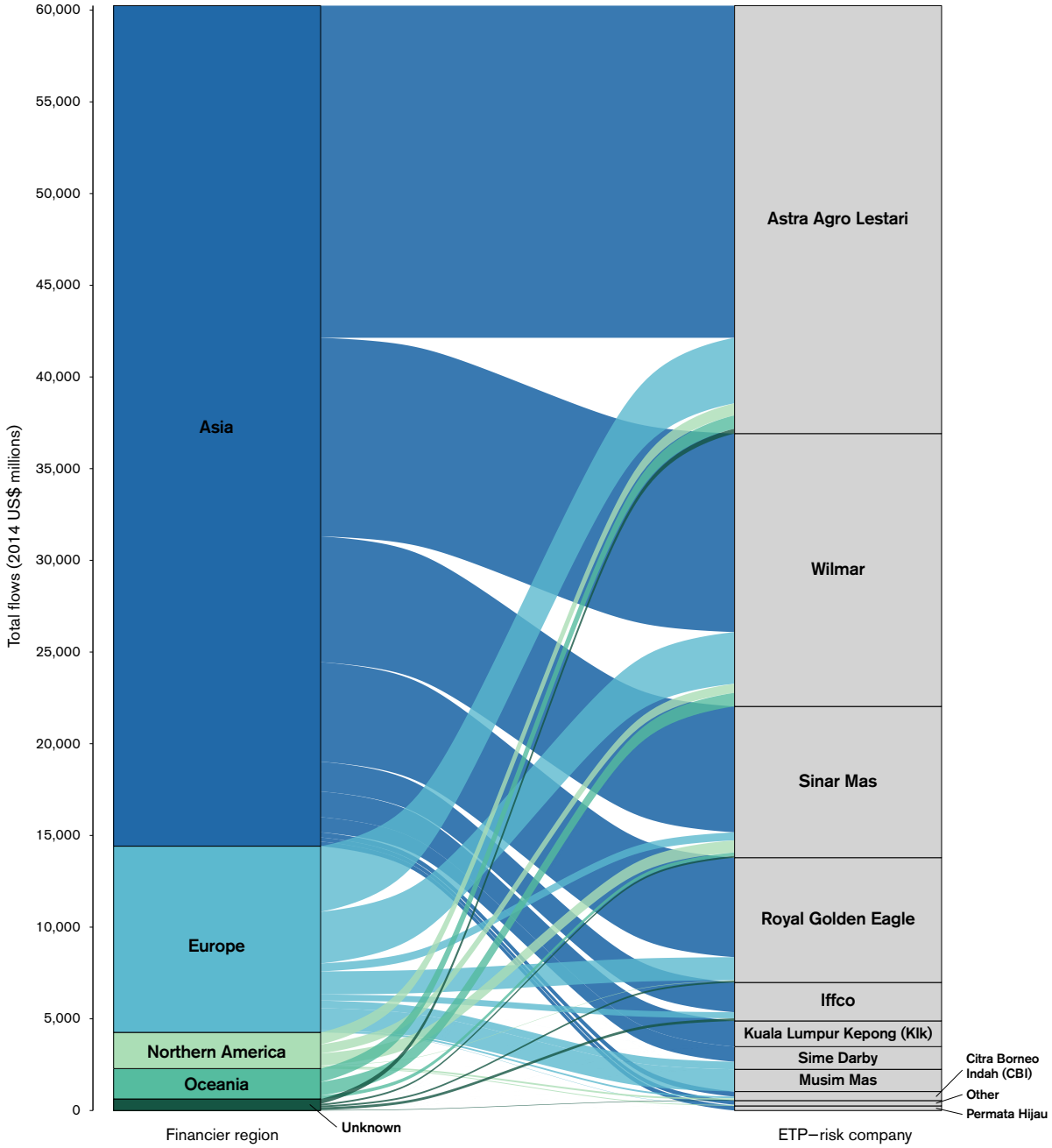


Figure 7: Map of the geography of institutions providing and facilitating financial flows to ETP risk companies for (a) the Brazilian Amazon and (b) Indonesian peatlands. Countries where financial flows are attributed to filled in lilac, while countries with no associated financial flows are filled in grey. The Brazilian Amazon and Indonesian peatlands are filled in green. The size of the circles indicated the size of the financial flow. The names of the top 10 countries are displayed on the map.

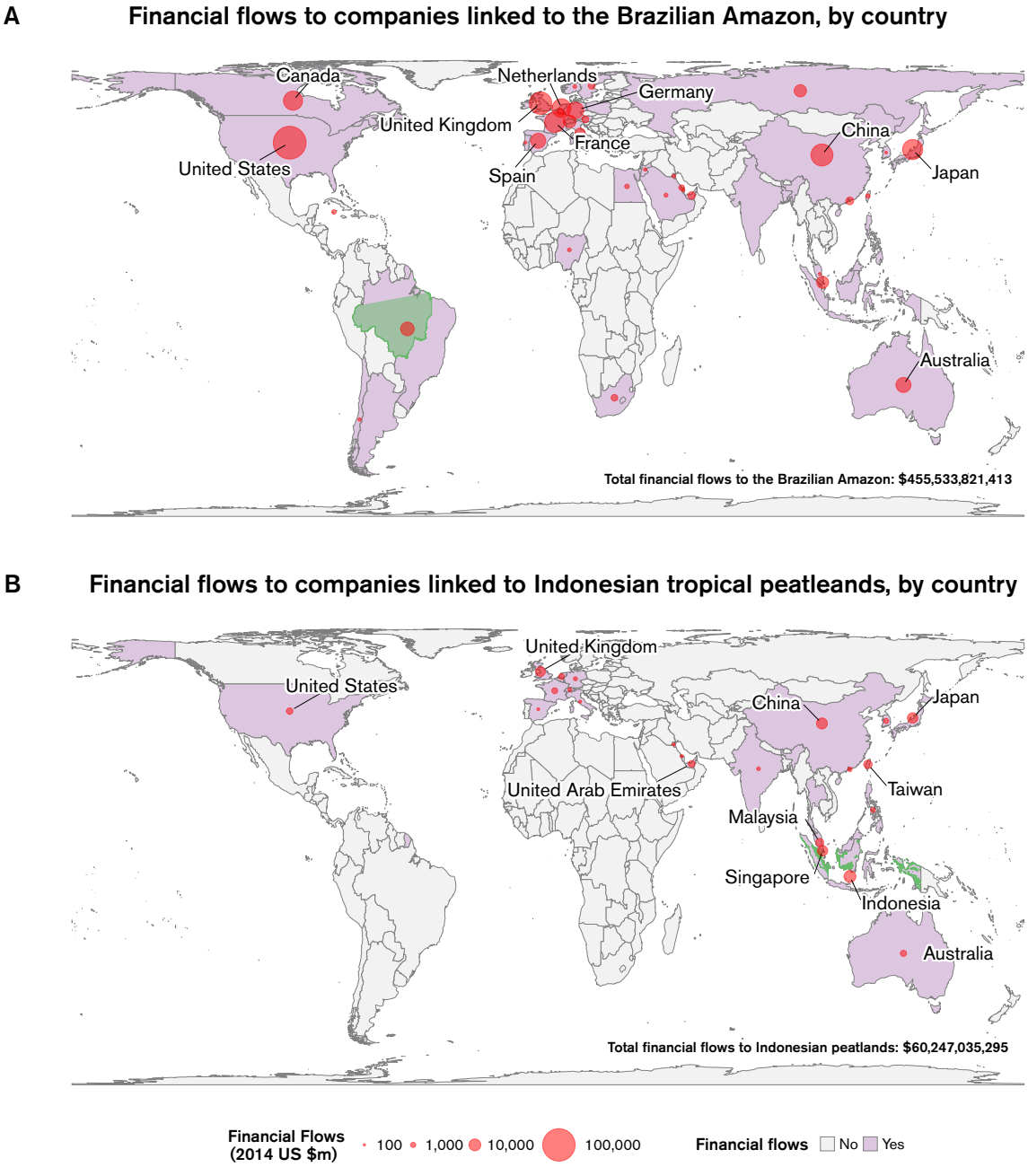


Figure 8: Brazilian Amazon – institutions providing and facilitating financial flows to companies linked to deforestation. Institutions with a government ultimate parent are marked with asterisks.

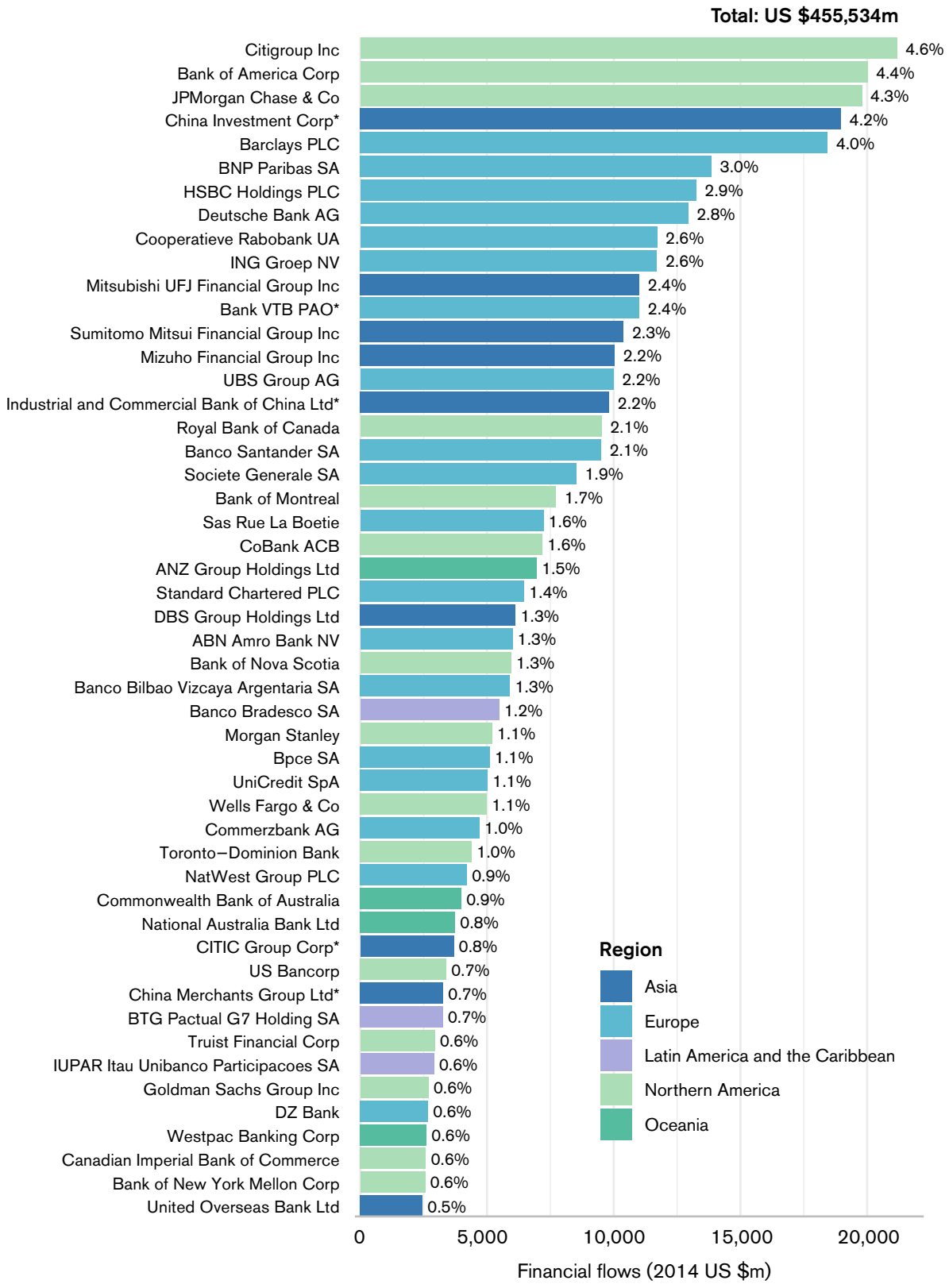
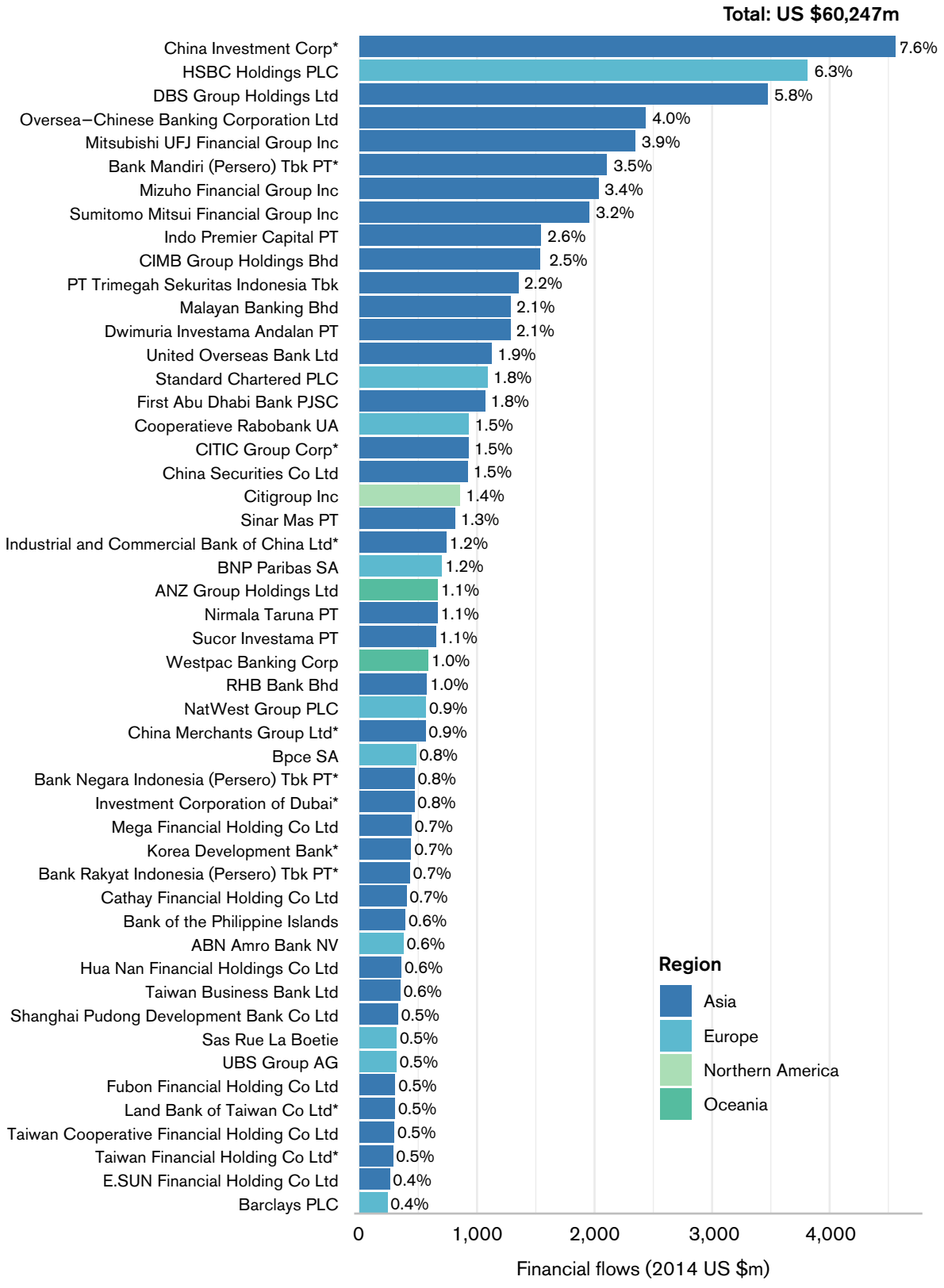


Figure 9: Indonesian peatlands - institutions providing and facilitating financial flows to companies linked to land use on peatlands. Institutions with a government ultimate parent are marked with asterisks.



We found that a small number of institutions provided or facilitated most of the financial flows to ETP risk companies. Out of 238 financial institutions, the top 50 accounted for 86.3 per cent of financial flows to companies linked to the Brazilian Amazon, with the top 10 accounting for 35.5 per cent (Figure 8) out of the 154 institutions financing companies linked to the Indonesia peatlands, the top 50 institutions facilitated 83.6 per cent of financial flows and the top 10 accounted for 42.8 per cent.

Flows were largely attributed to private financial institutions, concentrated in a handful of financial centres (Table 8, Appendix). These were the United States, European Union, and UK for the Brazilian Amazon case, and Japan, Indonesia and the UK for the Indonesian peatlands. Thirteen per cent and 20.7 per cent of financial flows were attributed to institutions ultimately owned by governments for the Brazilian Amazon and Indonesian peatlands, respectively; primarily the Chinese or Indonesian governments (Figure 8, Figure 9).

For many of the most implicated financial institutions, financial flows to ETP risk companies were small relative to their overall activities. Using 2023 data, we compared financial flows to ETP risk companies to overall lending and capital markets flows, for the top 10 financial institutions implicated in each ecosystem (Table 10, Appendix). Financial flows were less than 1 per cent of overall flows for nine of the top 10 financial institutions for the Brazilian Amazon (less than 5 per cent for the remaining institution). For the Indonesian peatlands, financial flows were less than 1 per cent for five of the top 10 companies for the Indonesian peatlands (less than 6 per cent for a further four). An exception was Indo Premier Capital, one of the largest institutional underwriters in Indonesia, where financial flows to just two ETP risk companies (Sinar Mas and Astra Agro Lestari) accounted for 47.5 per cent of its traceable financial flows in 2023.

4.3 Financial influence

The previous section demonstrated that many (but not all) ETP risk companies interact significantly with parts of the global financial system through their external financing patterns. Here, we explore what metrics of external financing (particularly debt) sensitivity tell us about how finance-based measures could impact companies' activities, in addition to increasing the resilience of financial institutions. This balance sheet data was available for a subset (15 out of 24) of the ETP risk companies that had financial flows data.

We found a significant degree of heterogeneity in these ratios (Figure 11). In the Brazilian beef sector, companies had debt-to-asset ratios in 2023 that were well above the global, emerging markets, and consumer non-cyclicals averages. They also had very low retained earnings to total assets compared to other ETP risk companies. Several palm oil and pulp and paper companies, such as Wilmar, Batu Kawan (associated with Kuala Lumpur Kepong (KLK)), and Toba Pulp Lestari (associated with Royal Golden Eagle – see Figure 11 caption) were similar. This combination of higher-than-average debt-to-asset ratios, low or negative retained earnings, and interest coverage ratios below industry averages indicates these companies may be more

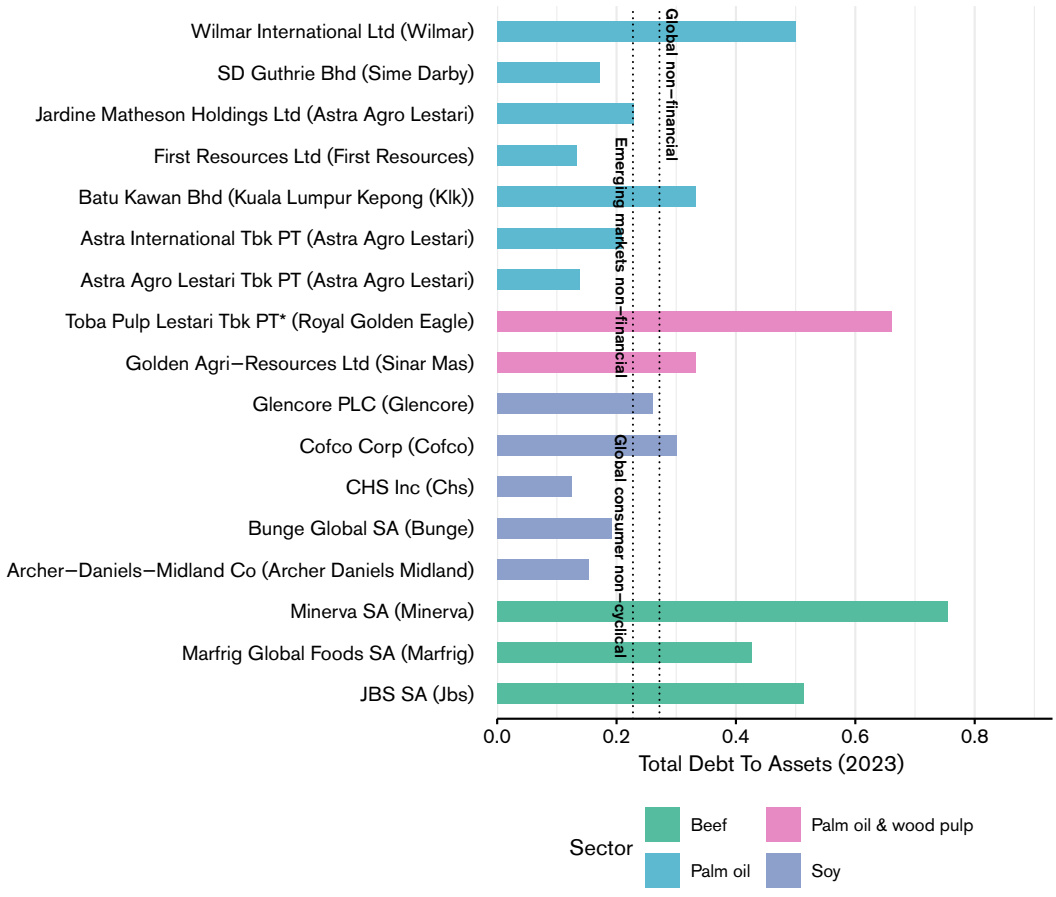
vulnerable to negative changes in external financing conditions, particularly if ratios have worsened over time (Figure 12, Appendix).

However, the balance sheets of other ETP risk companies indicate they could be relatively insulated from negative changes in external financing conditions as they have a low reliance on external debt finance, high retained earnings (likely arising from significant profits) and strong interest coverage ratios compared to industry averages. This included most of the companies associated with Brazilian soy – CHS Inc, Bunge, and Archer Daniels Midland – and some palm oil companies. Many companies appeared to decrease their reliance on external financing, and particularly debt, over the study period (Figure 12, Appendix).

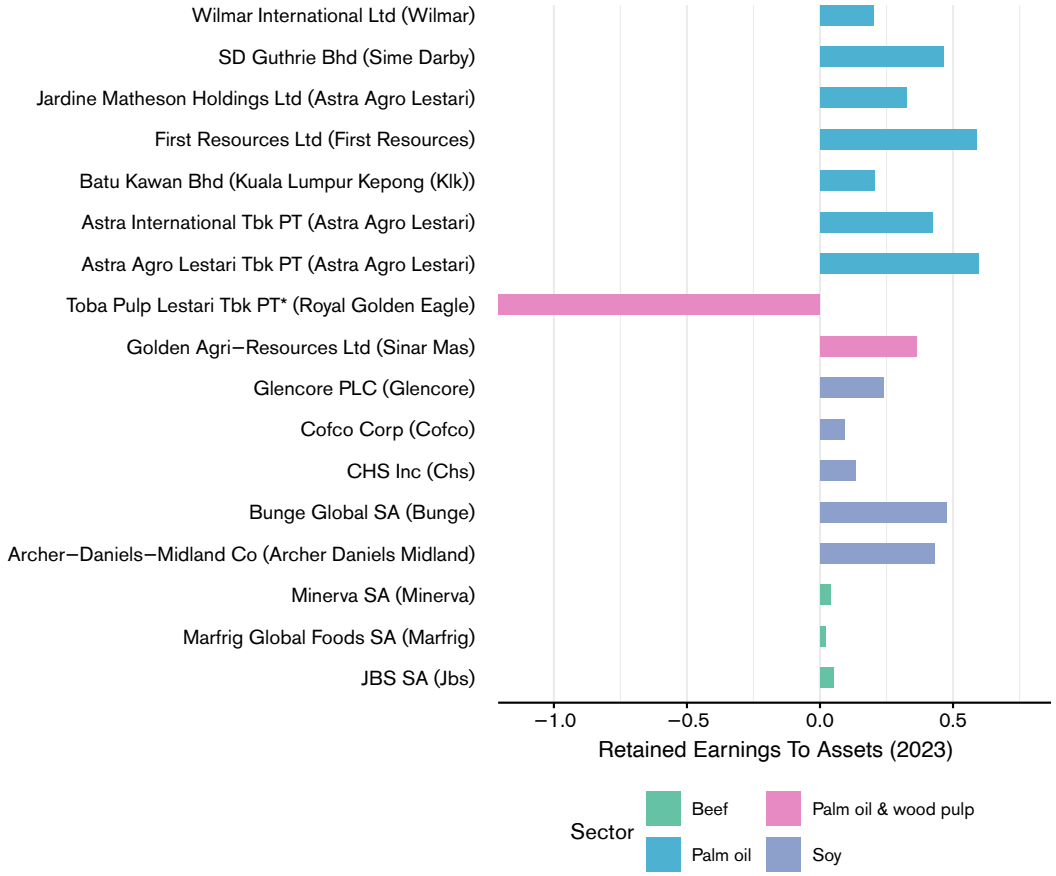
Overall, our results suggest that some, but not all, ETP risk companies are likely to be vulnerable to negative changes in external financing and credit conditions, which could have implications for whether finance-based measures significantly influence their activities. In the next section, we discuss the implications of these results together with our analysis of financial flows and the related literature.

*Figure 10: Financial ratio analysis of ETP risk companies for 2023 covering (a) total debt to assets, (b) retained earnings to assets, and (c) interest coverage ratios. Industry comparators for global non-financial, emerging markets non-financial, and global consumer non-cyclical corporates sourced from LSEG. No industry averages were available for retained earnings to asset ratios. *Toba Pulp Lestari Tbk PT (TPL) is listed here as being associated with Royal Golden Eagle (RGE) group, as per TSC data. However, RGE and TPL maintain that they are independent entities. See our methodology for more information.*

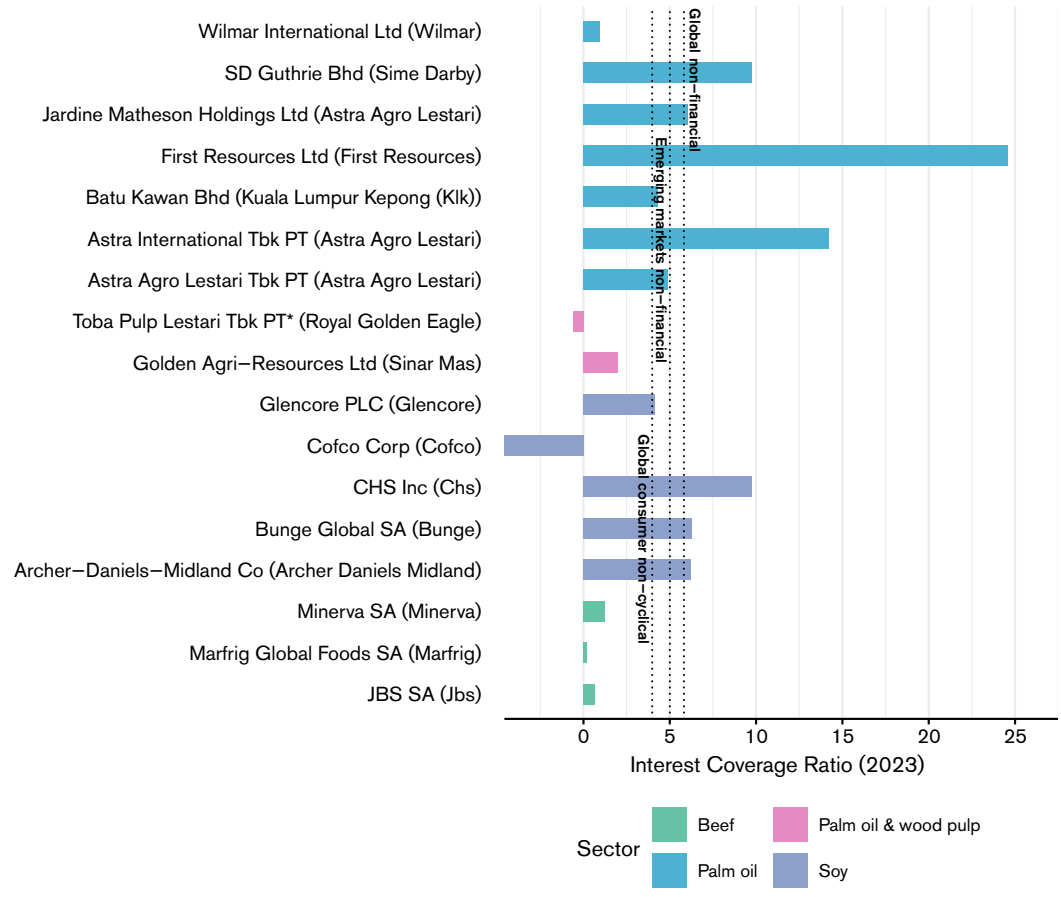
a.



b.


Wilmar International Ltd (Wilmar)
SD Guthrie Bhd (Sime Darby)
Jardine Matheson Holdings Ltd (Astra Agro Lestari)
First Resources Ltd (First Resources)
Batu Kawan Bhd (Kuala Lumpur Kepong (Klk))
Astra International Tbk PT (Astra Agro Lestari)
Astra Agro Lestari Tbk PT (Astra Agro Lestari)
Toba Pulp Lestari Tbk PT* (Royal Golden Eagle)
Golden Agri−Resources Ltd (Sinar Mas)
Glencore PLC (Glencore)
Cofco Corp (Cofco)
CHS Inc (Chs)
Bunge Global SA (Bunge)
Archer−Daniels−Midland Co (Archer Daniels Midland)
Minerva SA (Minerva)
Marfrig Global Foods SA (Marfrig)
JBS SA (Jbs)
−1.0
−0.5
0.0
0.5
Retained Earnings To Assets (2023)
Sector
Beef
Palm oil
Palm oil & wood pulp
Soy

c.


Wilmar International Ltd (Wilmar)
SD Guthrie Bhd (Sime Darby)
Jardine Matheson Holdings Ltd (Astra Agro Lestari)
First Resources Ltd (First Resources)
Batu Kawan Bhd (Kuala Lumpur Kepong (Klk))
Astra International Tbk PT (Astra Agro Lestari)
Astra Agro Lestari Tbk PT (Astra Agro Lestari)
Toba Pulp Lestari Tbk PT* (Royal Golden Eagle)
Golden Agri−Resources Ltd (Sinar Mas)
Glencore PLC (Glencore)
Cofco Corp (Cofco)
CHS Inc (Chs)
Bunge Global SA (Bunge)
Archer−Daniels−Midland Co (Archer Daniels Midland)
Minerva SA (Minerva)
Marfrig Global Foods SA (Marfrig)
JBS SA (Jbs)
Global non−financial
Emerging markets non−financial
Global consumer non−cyclical
0
5
10
15
20
25
Interest Coverage Ratio (2023)
Sector
Beef
Palm oil
Palm oil & wood pulp
Soy

5. Discussion

There has been extensive research demonstrating the outsized influence of large, multinational agri-food companies on soft commodity flows, land use change, and ecological and social impacts (Murphy et al., 2012; Lyons-White and Knight, 2018; Folke et al., 2019; Folke et al., 2020; Rajão et al., 2020; Clapp, 2021). Our results analysing TSC data reinforce these findings and support a focus on traders as important midstream actors for sustainability (Grabs and Carodenuto, 2021; Grabs et al., 2024). There is ongoing debate over whether such high levels of concentration in sectors that are important for Earth system stability present an opportunity or challenge for environmental governance (Folke et al., 2019; Schneider et al., 2020; Österblom et al., 2022). However, until now, there has been less research exploring the financing of these companies and the governance implications of these financial interactions.

A key finding is that the financial flows directed towards companies linked to agricultural impacts in the Brazilian Amazon and Indonesian peatlands are concentrated in a small group of actors. A handful of primarily private institutions provided and facilitated most financial flows over the study period; the top 10 institutions accounted for 35.5 per cent and 42.8 per cent of financial flows for the Brazilian Amazon and Indonesian peatlands, respectively. This is consistent with previous findings that stock measures of financial interactions like equity holdings were concentrated in a few financial actors for the agri-food, fisheries, and fossil fuel sectors (Galaz et al., 2018b; Jouffray et al., 2019; Dordi et al., 2022; Galaz et al., 2023). While we do not compare levels of concentration directly, other analysis of hard and soft commodity traders found that lending tends to be concentrated in fewer actors than bond or equity holdings (Baines and Hager, 2022).

Our results illuminate a new set of financial actors that could be important leverage points to influence economic activity in two critical ecosystems. Network analysis could be a fruitful direction for further research, since this can better illuminate interconnectedness, sources of power and centrality, and compensate for some of the limitations of comparisons based on financial value alone (Vitali et al., 2011; Galaz et al., 2023). This could also explore how financial risks from exposure to ETP risk companies, such as environment-related transition risks, could propagate through the financial system.

Finance flows along different geographic lines to physical flows

Our findings support research framing land use change and degradation as a globally systemic driver of nature loss, characterised by complex cross-scale interactions and teleconnections (Marques et al., 2019; Newig et al., 2020). Empirical data exploring these interactions has focused on demand and trade patterns (Pendrill et al., 2019a; Pendrill et al., 2019b), or equity holdings (Galaz et al., 2023). We build upon this research by showing that land use dynamics linked to agriculture in critical ecosystems in Brazil and Indonesia is not just driven by physical flows (such as trade in commodities) but is also associated with financial flows of various asset classes, which implicate a distinct set of geographies.

Domestically headquartered financial institutions played only a minor role in our data for the Brazilian Amazon. Instead, financial institutions headquartered in the United States, Japan and

Europe were particularly prevalent. This contrasts with trade flows data, where consumption by domestic actors and China are the most implicated in forest loss associated with beef and soy production (Fearnside et al., 2013; Reis and Prada Moro, 2022; Reis et al., 2023; Haddad et al., 2024). Financial flows attributed to EU-headquartered financial institutions, when considered collectively, accounted for an even greater proportion than the US. This is important in the context of the bloc's efforts to reduce the deforestation associated with its physical import of agricultural commodities, including from Brazil (Titley, 2024).

For the Indonesia peatlands, financial flows were more similar to physical flows of agricultural commodities. The key institutions facilitating financial flows to ETP risk companies were headquartered in Indonesia, China, and Singapore, all of which are major consumers of palm oil and wood pulp or intermediate products (Heilmayr and Benedict, 2022; Conservation Economics Lab et al., 2023). Despite not being major import partners, Japanese and UK institutions facilitated significant flows, while the EU – a key palm oil importer – did not.

Methodological limitations

It is important to highlight that this analysis of companies implicated in land use (change) and their financial flows faces methodological limitations. We used TSC data to link ETP risk companies to metrics of land use (change) in the Brazilian Amazon and Indonesian peatlands. This is constructed by TSC using material flow analysis and supply chain modelling. Metrics are estimates and are not representative of full traceability and attribution of commodity flows to each ETP risk company. This, together with TSC data being backwards-looking, means that analysing a more contemporary dataset from traceability data may yield different companies implicated in land use (change). It also means that our data does not account for recent developments such as mergers and acquisitions. For example, the planned acquisition of Glencore's agriculture arm, Viterra, by Bunge would change our analysis (Ljunggren et al., 2024). Also, TSC cannot attribute physical flows for domestic consumption to individual companies. Those responsible for the most exports are often big players in domestic markets too; for example, JBS, Minerva, and Marfrig dominate the Brazilian cattle industry (Drost et al., 2022). However, TSC data may overrepresent companies focused on international markets due to this limitation.

In terms of financial flows data, LSEG poorly covers bilateral deals since they do not have the same visibility or reporting requirements. Our dataset is, therefore, likely biased towards syndicated transactions in large markets. This could explain why we were unable to trace financial flows to most domestic, focused companies. Incomplete corporate hierarchies and limited data on public finance also suggests our data is probably an underestimate. We attributed financial flows to the ultimate parent of the financial institution due to uncertainties at more granular levels. This obscures cross-border features such as whether domestic subsidiaries of foreign financial institutions participated in transactions. Finally, we considered the data for each ecosystem separately, rather than making cross-case comparisons, which, when based on financial value alone, can be misleading (Vitali et al., 2011; Galaz et al., 2023). Despite this, factors such as differences in purchasing power and moving foreign-exchange rates likely affect

our descriptive statistics, since the companies and financial institutions we explore operate at a multinational scale.

These limitations mean that our analysis should be taken as initial exploration and could be improved by more accurate traceability and financial data that could align timelines between financial flows analysis and concurrent land use dynamics. We also did not analyse the environmental risk management policies of individual companies or financial institutions as part of this study. Some institutions included in our research have sustainability policies in place for their supply chains and/or clients. Important progress has been made on such policies in recent years, though reviews suggest they may not yet be sufficiently robust (see Forests & Finance, 2022; Thomson and Franklin, 2024). Further research could include a qualitative analysis of these risk management practices to determine their effectiveness for the ecosystems we highlight here.

Distancing between financial actors from on-the-ground impacts

Our methodology, results, and their limitations illustrate a wider issue in tracing empirically how finance may indirectly contribute to land use change and environmental degradation more broadly (Meyfroidt, 2016). Few financial flows could be explicitly traced to harmful activities in the specific ecosystems we focused on. Instead, most financial flows were provided as funding for general corporate purposes and other unrestricted forms. These flows were, in turn, mediated through a complex set of intermediaries before reaching actors directly involved in deforestation. We found some evidence that companies lend to themselves through financial subsidiaries, adding additional complication and consistent with evidence in the US agriculture sector of prevalent intracompany lending (Ashwood et al., 2022). Here, as found in previous research (e.g., Galaz et al., 2018a; Clapp, 2019; Ouma, 2020), we show that causes and effects are essentially "distanced" through a network of supply-chain and financial linkages that make it very difficult to trace causality using available data.

Greater long-term disclosure of how capital is distributed across a company's subsidiary structure could be a first step to addressing this problem (Galaz et al., 2018a). However, a more discretionary view could also be taken of responsibility for ecologically harmful activities at the ultimate parent level. A precautionary approach (Chenet et al., 2021; Kedward et al., 2022) would suggest that any finance, including general corporate purpose, given to an ETP risk company could be supporting harmful activities until the entire company transforms.

Financial flows as a leverage point

The sustainability transitions literature has suggested that finance could be an important leverage point in accelerating the transition away from ecologically harmful practices in extractive sectors, including agriculture (Galaz et al., 2018b; Jouffray et al., 2019; Galaz et al., 2023; Dordi et al., 2022; Dordi et al., 2023). We demonstrate that – in the case of agriculture in Brazil and Indonesia – this leverage may not be equally powerful in all cases. Many, but not all, of the companies most linked to land use (change) in our data interacted with the global financial system. We traced financial flows to companies linked to less than 50 per cent of land use

change for beef. This could be due to data limitations described above, or may suggest that some ecologically important companies fund their continued activities through other ways, such as capital surpluses (Richards and Arima, 2018), public credit schemes (Souza et al., 2020), or from other agricultural actors (Sosa Varrotti and Gras, 2021).

The companies in our data that did raise finance were not unilaterally sensitive to changes in external financing conditions. Many companies, linked to Brazilian soy and Indonesian wood pulp, have strong retained earnings, low debt-to-capital ratios and high interest coverage ratios, suggesting significant internal funding capacity. Such strong financial positions may limit the extent to which companies' activities would be affected by measures to restrict or increase the cost of external finance. These multinational actors appear less credit-constrained than small-scale farmers further up the value chain, where econometric evidence shows that restrictions on rural credit can lead to material decreases in levels of deforestation (Assunção et al., 2019). Our findings support recent research showing that large commodity traders have deleveraged over time, a practice that may "insulate" them from ecologically-minded financial actors seeking to steward their behaviour in line with long-term sustainability (Baines and Hager, 2022). Such strong financial positions likely result from recent supply shocks that have spiked the prices of agricultural commodities, combined with market power (Clapp, 2021; Hobson, 2022; Weber and Wasner, 2023). Some ETP risk companies – especially in beef, which is more pressing for Brazilian Amazon deforestation than soy – do appear to be much more financially constrained. Here, finance-based measures may be more effective. However, it is important to note that myriad institutional, political and economic factors – beyond the provision of finance – drive agricultural expansion and ecological degradation in many economies (Svartzman and Althouse, 2022; Althouse and Svartzman, 2022).

6. Conclusion and policy implications

Preserving the Amazon rainforest and remaining Indonesian peatlands is essential for environmental, economic and financial stability. Economies and the financial system will be subject to significant risks if these ecosystems cross tipping points that permanently diminish their functions. An emerging literature action also points to financial actors as relevant to driving, and potentially reducing, ecosystem degradation.

In this paper, we aimed to explore these dynamics by mapping financial flows to the companies most implicated in land use change and degradation in two critical ecosystems: the Brazilian Amazon and Indonesian peatlands. We identified the main types of finance, geographies, and actors implicated. We used ratio analysis to contextualise the potential effectiveness of finance-based measures – such as increasing the cost-of-capital for these companies – in impacting their activities to explore whether policy measures may reduce, as well as build resilience to, environment-related financial risks.

We found that most financial flows were syndicated loans (63.1–70.3 per cent), although bond

issuances were also significant (28.0–30.6 per cent). Financial flows were concentrated in relatively few institutions headquartered in several key geographies – the United States, China, Japan, Indonesia, the European Union, and the United Kingdom. These could be key intervention points for sustainability transitions in these companies. However, there was significant heterogeneity regarding how companies interacted with and depend on external finance. Moreover, the complexity of both corporate and financial structures presented challenges to tracing specific financial flows to on-the-ground impacts.

Our results have several policy implications. Companies linked to land use change and land use in the Brazilian Amazon and Indonesian peatlands respectively interact significantly with the global capital markets on different geographical lines to physical commodity flows. There is an argument that governments aiming to limit their impacts on foreign ecosystems should consider financial flows alongside supply chains in accounting for their full share of international responsibility. This is relevant for upcoming regulatory discussions about whether to include financial institutions in the EUDR (European Union, 2023) and the UK's forest rule, which has been subject to significant delays (Bellfield, 2024; Global Witness, 2024). Given the complexity of financial interactions, it would be sensible to apply such due diligence requirements at the group level (Greenpeace International et al., 2024).

Some authors have proposed to manage environment-related financial risks by tackling financial flows to harmful activities, such as those linked to tipping points, in light of limits to how meaningfully the risks to individual institutions can be calculated through disclosure and forward-looking scenario analysis (Chenet et al., 2021; Kedward et al., 2022; Irvine-Broque and Dempsey, 2023; Kedward et al., 2024). This "precautionary approach" prioritises the risks that financial institutions pose to ecosystems, rather than aiming to quantify how ecosystem change may affect financial institutions, which is subject to fundamental uncertainty given the complexities of non-linear environmental change and its impacts on a highly interconnected macro-financial system (Bolton et al., 2020; Chenet et al., 2021).

We show that such measures, in the case of the Brazilian Amazon and Indonesian peatlands, would only require coordination across relatively few financial centres to cover a substantial portion of financial flows to ETP risk companies. Financial regulation should go beyond banking supervision, since close to one-third of flows were provided via capital markets by non-bank financial institutions, facilitated by investment banks. The financial flows we map are relevant to prudential policymakers since, if they remain on-balance sheets, they could be sources of transition risks as companies face increasingly stringent regulations aimed at halting and reversing nature loss. Relatively small financial exposures to ETP risk companies would suggest that financial institutions may not view them as major risks, and therefore they may not act in a timely fashion to mitigate potential transition risks (Boissinot et al., 2022; ECB/ESRB, 2022). Indeed, recent analyses of environmental risk management policies implemented voluntarily by financial institutions found they remain inadequate when it comes to deforestation (Thomson and Franklin, 2024). This suggests a role for macroprudential policymakers, since excessive financing of environmentally harmful activities can increase physical risk for the entire financial system, even if the risk to individual institutions appears low.

However, the heterogeneity in the internal financing capacity of ETP risk companies studied here, such as the resilience provided by high levels of retained earnings, suggests that reorienting financial flows cannot be seen as a silver bullet to unilaterally prevent their expansion and, in turn, reduce indirect land use pressure on two of the world's most critical ecosystems. This does not mean finance is not important, especially given that policies aimed at reorienting financial flows could have spillover and signalling effects that are much greater than initially anticipated effects on access to or cost of capital would imply (Eker et al., 2024).

We suggest that direct environmental regulation, higher taxes of the profits of ETP risk companies and industrial policy reforms focused on developing more sustainable export industries will be needed, in a coordinated manner, to encourage these firms to transition to activities that do not harm nature. This must be done in conjunction with financial reforms that focus not only on potentially harmful financial flows but also on how the international monetary and financial system constrains countries hosting the planet's most important ecosystems (Svartzman and Althouse, 2022; Dempsey et al., 2024).

Tackling the indirect drivers of land use change and degradation is a complex policy challenge that warrants further research. This paper has contributed by exploring the potential for financial policy interventions to support this process in two critical ecosystems. Given the significant environmental, economic and financial risks posed by ETPs, financial policymakers acting in coordination with other public actors can play an important role in helping to halt and reverse drivers of ecosystem collapse, as part of a wider precautionary approach to environmental policy.

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Appendices
A1 Additional explanation on methodology

A1.1 Methodology using TSC data

We used TSC as the best-available data for mapping environmental metrics to individual corporate supply chains, in the absence of full traceability and disclosure of supply chain data. We do not suggest that companies are directly responsible for these land use (change) metrics, rather that – based on the best-available data – they have sourced from regions where land use (change) is taking place for that commodity and therefore indirectly influence these dynamics. Production location resolution in TSC depends on the level of uncertainty in the methods used – soy, beef, and palm oil are more heavily reliant on modelling of supply chain locations, whereas TSC makes use of high levels of traceability in the sector to link sourcing of wood pulp down to the concession level. Both sourcing patterns and associated environmental metrics in the TSC data should therefore be taken as estimates.

For the Brazilian Amazon, "deforestation exposure", was embedded in the TSC data at the municipality level and we filtered to only include the Amazon biome. For the Indonesian peatlands, we harmonised peatland area data - available per concession and per kabupaten for wood pulp and palm oil (see Trase, 2022; Benedict et al., 2023) – with sourcing volumes data at the same level of granularity i.e., at the concession and kabupaten level respectively for wood pulp and palm oil. We apportioned the total commodity area planted on peat (per sourcing location, per year) between companies based on their individual volumes sourced, relative to the total volumes sourced from that sourcing location for that year. This included attributing a portion to domestic consumption or processing. We then calculated the mean of each metric over the most recent three years of data, since TSC data is not additive, to account for volatility while using the most contemporary data possible (2018–20 for soy and palm oil, 2019–20 for beef, 2020–22 for wood pulp).

We then excluded domestic consumption from our significance analysis because this is not attributed to individual companies in TSC, before selecting all companies that corresponded to at least 1% of remaining land use (change) exposure, averaged over the most recent years of data. Therefore, the % amount that we attribute to each company should be considered not as a proportion of all land use (change) for that ecosystem. There may be other important companies that are more domestically oriented that we do not highlight, as they will not show up in TSC data. Domestic consumption or processing accounted for 13.5%, 36.9%, and 37.5% of our metrics for soy (Brazilian Amazon), pulpwood (Indonesia peatlands), and palm oil (Indonesia peatlands) respectively, whereas no data on domestic consumption was available for beef (Brazilian Amazon). We did not compare the absolute amounts we calculate from TSC to company reporting, but they may differ due to TSC's reliance on modelling, the inclusion of third-party suppliers, and the role of domestic consumption. Our list of "ETP risk companies" is not exhaustive and should not be taken as such. For more information on the various assumptions, limitations and trade-offs associated with TSC data, see the methodology documents at https://trase.earth/open-data.

A1.2 Methodology for parsing financial flows

For lending and capital markets underwriting, the total deal amount is known. However, the contributions of individual financial institutions to this total are not always public. LSEG contained information on these "committed" or "allotted" amounts for a minority of deals. These amounts are not always correct, by which we mean the reported committed/allotted amounts sum to a different total than the reported deal amount. This is usually done for the following reasons: rounding errors; committed/allotted amounts are only known for some banks in the deal; committed/allotted amounts are reported for the total package (where there are multiple deals or "tranches"); or committed/amounts appear to simply be incorrect (that is, they are available for all financial institutions in the deal, but do not sum either the tranche or package value).

We aimed to include, to the largest extent possible, the reported amounts where they were included in LSEG. However, to prevent discrepancies from distorting our data, we kept reported committed/allotted amounts only where they were available for all institutions at the deal (rather than the total package) level and where the discrepancy between the sum of reported committed/allotted amounts was less than 1 per cent of the reported deal amount. This allows for some small rounding errors, following Chu et al. (2019) and (Benincasa, 2021). This excluded 26 deals where committed/allotted amounts were available.

For all the deals where there was no information on the committed/allotted amounts per FI (and those where we excluded the reported information), we instead estimated the individual amounts. We explored three avenues:

1) Splitting the deal amount equally between bookrunners only: this method is often used by industry providers to construct league tables of syndicated lending and capital markets activity. It will systematically overrepresent the contributions of bookrunners (who front a larger portion, but usually not all, of the deal total) and underrepresent the contributions of banks that regularly take on more minor roles in deals (fronting a smaller but still non-zero portion of the deal total).

2) Splitting the deal amount equally between all participating institutions: this is the simplest method but will systematically underrepresent contributions of banks who regularly act as bookrunners (who front a larger portion of the deal total) and overrepresent the contributions of banks who regularly take on more minor roles in deals (who front a smaller portion of the deal total).

3) Splitting the deal amount using a ratio that apportions the total between bookrunners and other managers on the deal, based on (Warmerdam, 2020). This method apportions between the bookrunners and non-bookrunners based on the assumption that, as the number of participants increases, the importance of the bookrunner decreases. It prevents very large differences in amounts attributed to bookrunners and other participants.

The bookratio method (see Equation 1) is taken from Warmerdam (2020)[10] and recognises that bookrunners play a more important in issuances rather than lending. There are typically several hierarchical levels of participation in lending and capital markets deals, ranging from bookrunners to non-managing syndicate members (e.g. Carbó-Valverde et al., 2021). Whilst splitting into binary levels – bookrunner and participant – is a simplification, since there are multiple tiers in syndicated lending, this is consistent with the wide literature on syndicated loans (Becker et al., 2024).

Equation 1: Bookratio calculation

$$BR = \frac{\sum n_{manager} - \sum n_{bookrunner}}{\sum n_{bookrunner}}$$

Table 2: Proportion assigned to bookrunner group depending on total number of managers and bookrunners on a deal

	Proportion assigned to bookrunner group	
Bookratio	*Loans*	*Issuances*
1/3 < BR 2/3	75%	75%
2/3 < BR 1.5	60%	75%
1.5 < BR 3.0	40%	75%
3.0 < BR	$\frac{(1/\sqrt{BR})}{1.443375673}$	$\frac{(1/\sqrt{BR})}{0.769800358}$

It is possible to observe how Methods (1), (2) and (3) either concentrate or spread the total amount between institutions, with the equal split between bookrunners substantially increasing the proportion of the total amount attributed to the top FIs. The order of the top 10 (for overall flows, not split by ecosystem) changes based on the method. For example, in method (1) China Investment Corp ranked 10th, whereas in methods (2) and (3) it ranked sixth and seventh, respectively.

10 Profundo derived its formula by running a regression analysis on bank finance data in order to predict which factors were most significant in explaining banks' contribution value. They found that bank contributions could be predicted based on the banks' roles, the number of deal participants, and the type of financing. Thus, the value of the deal is divided among all known participants, with a greater share allocated to the banks in leading roles (bookrunners).

Table 3: Difference in concentration of flows depending on method used to parse deal amounts between individual institutions.

Method	Proportion of total amount attributed to top 10 FIs
(1) Equal split between bookrunners	51.5%
(2) Equal split between all managers	38.3%
(3) Split based on bookratio	41.1%
(4) Combine reported committed/allotted amounts (when accurate) with split based on bookratio where not available	41.4%

The syndicated lending literature tends to either exclude transactions without commitment information (Ivashina and Scharfstein, 2010; Chu et al., 2019) or splits equally between participants (Doerr and Schaz, 2021; Becker et al., 2024). However, when reviewing the reported committed/allotted amounts where data were available and sufficiently accurate, only 3.6 per cent of reported committed/allotted amounts for non-bookrunners were 0; that is, there were very few cases where the bookrunners provided all the capital. It would not reflect the data we do have to only split the transaction volumes between bookrunners. However, the data showed that, on average, bookrunners committed around twice as much as non-bookrunners, so an equal split between all managers would over-allocate to non-lead institutions and under-allocate to bookrunners.

We moved forward with a split based on the bookratio method for deals where reported committed/allotted amounts were not available or not sufficiently accurate. This results in a slight overestimation of the total flows when using the parsed values of USD $52.9 million, or 0.0068 per cent of the original total flows. It is important to note that these amounts are only estimates – this could be improved by more transparent and accurate data on commitment/allotted amounts by service providers.

A2. ETP risk companies

Table 4: Summary of identified companies

A) BRAZILIAN AMAZON

ETP risk company	ETP risk sector(s)	Deforestation exposure (ha)	Headquarters	Listing status	Horizontal integration	Geographic orientation	Financial flows data availability
Agroexport Trading E Agronegocios	Beef	28,307	Brazil	Private	Focused	Domestic	No
Amaggi	Soy	3,112	Brazil	Private	Focused	Domestic	Yes
Archer Daniels Midland	Soy	4,003	United States	Public	Diversified	Multinational	Yes
Bianchini	Soy	1,091	Brazil	Private	Focused	Domestic	No
Bull Log Trading Importaceo E Exportaceo Ltda Epp	Beef	16,183	Unknown	Unknown	Unknown	Unknown	No
Bunge	Soy	6,186	United States	Public	Diversified	Multinational	Yes
Cargill	Soy	3,963	United States	Private	Diversified	Multinational	Yes
CHS	Soy	876	United States	Public	Diversified	Multinational	Yes
COFCO	Soy	2,858	China	State-owned	Diversified	Multinational	Yes
Distriboi Industria Comercio E Transporte De Carne Bovina	Beef	5,547	Brazil	Private	Focused	Domestic	No
Engelhart	Soy	432	Brazil	Private	Diversified	Multinational	Yes
Frigol	Beef	8,340	Brazil	Private	Focused	Domestic	No
Frigorifico Fortefrigo	Beef	3,857	Brazil	Private	Focused	Domestic	No
Glencore	Soy	8,303	Switzerland	Public	Diversified	Multinational	Yes
Golden Imex	Beef	10,842	Brazil	Private	Focused	Domestic	No
Irmaos Goncalves Comercio E Industria	Beef	19,386	Brazil	Private	Focused	Domestic	No
JBS	Beef	59,040	Brazil	Part-listed	Focused	Multinational	Yes
Louis Dreyfus	Soy	3,132	Lichtenstein	Private	Diversified	Multinational	Yes
Marfrig	Beef	28,171	Brazil	Part-listed	Focused	Multinational	Yes
Masterboi	Beef	3,385	Brazil	Private	Focused	Domestic	No
Mercurio Alimentos	Beef	29,452	Brazil	Private	Focused	Domestic	No
Minerva	Beef	33,289	Brazil	Part-listed	Focused	Multinational	Yes
Plena Alimentos	Beef	2,922	Brazil	Private	Focused	Domestic	No
Vale Grande Industria E Comercio De Alimentos	Beef	15,300	Brazil	Private	Focused	Domestic	No

B) INDONESIA PEATLANDS

ETP risk company	ETP risk sector(s)	Land use on peatlands exposure (ha)	Headquarters	Listing status	Horizontal integration	Geographic orientation	Financial flows data
Astra Agro Lestari (Jardine Matheson)	Palm oil	42,280	Mulitple entities (Indonesia/Hong Kong)	Part-listed	Diversified	Multinational	Yes
Best Industry	Palm oil	21,283	Indonesia	Private	Focused	Domestic	No
Citra Borneo Indah (CBI)	Palm oil	17,511	Indonesia	Private	Diversified	Domestic	Yes
First Resources	Palm oil	36,034	Singapore	Part-listed	Focused	Multinational	Yes
Hayel Saeed Anam (HSA)	Palm oil	54,904	United Arab Emir-ates	Private	Diversified	Multinational	Yes
IFFCO	Palm oil	22,462	United Arab Emirates	Private	Diversified	Multinational	Yes
KPN Corp	Palm oil	66,191	Multiple entities (Singapore/ British Virgin Islands/ Indonesia)	Private	Diversified	Multinational	No
Kuala Lumpur Kepong (KLK)	Palm oil	32,166	Malaysia	Part-listed	Diversified	Multinational	Yes
Musim Mas	Palm oil	219,289	Singapore	Private	Focused	Multinational	Yes
Permata Hijau	Palm oil	39,328	Indonesia	Private	Focused	Domestic	Yes
Royal Golden Eagle	Palm oil / wood pulp	208,184 / 204,886	Multiple entities (Indonesia/ Singapore/UK)	Part-listed	Diversified	Multinational	Yes
Sime Darby	Palm oil	21,746	Malaysia	Part-listed	Diversified	Multinational	Yes
Sinar Mas	Palm oil / wood pulp	136,209 / 687,174	Multiple entities (Indonesia/ Singapore/ British Virgin Islands)	Part-listed	Diversified	Multinational	Yes
Torganda	Palm oil	15,991	Indonesia	Private	Focused	Domestic	No
Wilmar	Palm oil	160,443	Singapore	Part-listed	Diversified	Multinational	Yes

A3. Financial flows – additional data
A3.1 Breakdown by ETP risk company

Table 5: Financial flows between 2014 and 2023 by ETP risk company, with top five regions, countries, managing institutions, and asset classes shown.

a) Brazilian Amazon

ETP risk company	Financial flows (2014 US$)	Top regions	Top countries	Top managing institutions	Top asset classes
Amaggi	197	Asia (100%)	Japan (100%)	Sumitomo Mitsui Financial Group Inc (100%)	Loan (100%)
Archer Daniels Midland	51,114	Northern America (54%), Europe (34.1%), Asia (8.2%), Latin America and the Caribbean (2%), Oceania (1.1%)	United States of America (52.3%), United Kingdom (16.1%), Germany (5.5%), Japan (5.5%), Netherlands (4.7%)	Barclays PLC (12.7%), Citigroup Inc (12.5%), JPMorgan Chase & Co (12.5%), Bank of America Corp (12.4%), Northern Trust Corp (4.2%)	Loan (84.2%), bond issuance (15.3%), equity issuance (0.5%)
Astra Agro Lestari	23,335	Asia (77.6%), Europe (15.3%), Oceania (3.1%), Northern America (2.8%), Unknown (1.1%)	Japan (20.2%), Indonesia (18.2%), Singapore (18%), United Kingdom (14.2%), China (8.9%)	DBS Group Holdings Ltd (11%), HSBC Holdings PLC (10.4%), China Investment Corp (7.9%), Sumitomo Mitsui Financial Group Inc (5.8%), Mitsubishi UFJ Financial Group Inc (5.6%)	Loan (54.6%), bond issuance (43.2%), equity issuance (2.2%)
Bunge	37,213	Europe (37.8%), Northern America (37%), Asia (21.6%), Oceania (2.4%), Latin America and the Caribbean (0.8%)	United States of America (30.1%), Japan (15%), France (10.8%), Netherlands (8.3%), Canada (6.8%)	CoBank ACB (8.9%), Sumitomo Mitsui Financial Group Inc (8%), Citigroup Inc (5.1%), JPMorgan Chase & Co (4.9%), BNP Paribas SA (4.1%)	Loan (86.7%), bond issuance (13.3%)
Cargill	54,553	Europe (47.4%), Northern America (39.6%), Asia (9.7%), Oceania (2.3%), Latin America and the Caribbean (0.8%)	United States of America (34.9%), United Kingdom (14.8%), France (13.2%), Germany (8.5%), Japan (6.6%)	BNP Paribas SA (9.4%), Citigroup Inc (8.4%), Bank of America Corp (8.1%), JPMorgan Chase & Co (7.7%), Deutsche Bank AG (6.9%)	Loan (78.8%), bond issuance (21.2%)
Chs	13,157	Northern America (69.6%), Europe (16.9%), Asia (10.4%), Oceania (1.6%), Unknown (1.6%)	United States of America (66%), Japan (9.6%), Netherlands (6.2%), France (3.8%), Spain (3.6%)	CoBank ACB (12.6%), Bank of America Corp (12.2%), Wells Fargo & Co (10.3%), JPMorgan Chase & Co (8.5%), US Bancorp (6%)	Loan (82.1%), bond issuance (17.9%)
Citra Borneo Indah (Cbi)	494	Asia (56.3%), Europe (18.9%), Northern America (18.9%), Unknown (5.8%)	Malaysia (25.8%), France (18.9%), United States of America (18.9%), Indonesia (16.6%), Korea; Republic (S. Korea) (6.9%)	BNP Paribas SA (18.9%), CIMB Group Holdings Bhd (18.9%), Citigroup Inc (18.9%), Bank Rakyat Indonesia (Persero) Tbk PT (8.9%), Bank Mandiri (Persero) Tbk PT (7.8%)	Bond issuance (56.8%), loan (38.9%), equity issuance (4.4%)

ETP risk company	Financial flows (2014 US$)	Top regions	Top countries	Top managing institutions	Top asset classes
Cofco	51,653	Asia (79.5%), Europe (13.1%), Oceania (3.8%), Unknown (2.2%), Northern America (1.4%)	China (66.6%), Hong Kong (6.3%), United Kingdom (4.2%), Netherlands (4%), Singapore (3.9%)	China Investment Corp (28%), Industrial and Commercial Bank of China Ltd (13%), CITIC Group Corp (7.1%), China Merchants Group Ltd (6.3%), China Securities Co Ltd (2.9%)	Bond issuance (66.6%), loan (33.1%), equity issuance (0.3%)
Engelhart	6,666	Latin America and the Caribbean (46.7%), Europe (28.2%), Northern America (16.7%), Asia (4.6%), Unknown (3.8%)	Brazil (46.7%), United States of America (16.7%), Spain (11.9%), Switzerland (8.9%), Japan (4.6%)	Banco Bradesco SA (17.8%), BTG Pactual G7 Holding SA (14.8%), Banco Santander SA (11.9%), UBS Group AG (8.9%), Citigroup Inc (7.7%)	Bond issuance (59.6%), equity issuance (28.6%), loan (11.7%)
First Resources	252	Asia (100%)	Malaysia (60.8%), Singapore (26.1%), Japan (13.1%)	Malayan Banking Bhd (36.9%), RHB Bank Bhd (23.9%), DBS Group Holdings Ltd (13.1%), Sumitomo Mitsui Financial Group Inc (13.1%), United Overseas Bank Ltd (13.1%)	Loan (52.2%), bond issuance (47.8%)
Glencore	173,871	Europe (53.1%), Northern America (21.2%), Asia (15.7%), Oceania (6.8%), Africa (1.6%)	United States of America (12%), Canada (9.2%), France (9%), United Kingdom (8.9%), Japan (8.5%)	Bank VTB PAO (6.3%), UBS Group AG (4.3%), Citigroup Inc (3.7%), Deutsche Bank AG (3.3%), ING Groep NV (3%)	Loan (80.9%), bond issuance (16.9%), equity issuance (2.2%)
Hayel Saeed Anam (Hsa)	64	Northern America (73.3%), Europe (26.7%)	United States of America (73.3%), Netherlands (26.7%)	International Finance Corp (73.3%), Netherlands Development Finance Company NV (26.7%)	Loan (100%)
Iffco	2,096	Asia (77.5%), Europe (15.7%), Unknown (6.8%)	United Arab Emirates (68.5%), United Kingdom (15.7%), NA (6.8%), Kuwait (5.4%), Bahrain (3.6%)	Investment Corporation of Dubai (19.8%), First Abu Dhabi Bank PJSC (17.7%), HSBC Holdings PLC (15.7%), Dubai Islamic Bank PJSC (10.8%), Mubadala Investment Company PJSC (9.9%)	Loan (100%)
JBS	28,878	Northern America (50.6%), Europe (31.8%), Latin America and the Caribbean (9.9%), Asia (7.6%)	Canada (26.7%), United States of America (23.9%), United Kingdom (14.5%), Netherlands (9.3%), Brazil (9.1%)	Barclays PLC (14.5%), Royal Bank of Canada (13.6%), Bank of Montreal (13%), Mizuho Financial Group Inc (7.6%), Cooperatieve Rabobank UA (6.3%)	Bond issuance (67.1%), loan (30.2%), equity issuance (2.6%)
Kuala Lumpur Kepong (Klk)	1,402	Asia (100%), Europe (0%)	Malaysia (100%), United Kingdom (0%), Switzerland (0%)	Malayan Banking Bhd (48.3%), CIMB Group Holdings Bhd (33.2%), AMMB Holdings Bhd (9.2%), RHB Bank Bhd (9.2%), Fair Lead Enterprises Ltd (0%)	Bond issuance (94.1%), loan (5.8%), equity issuance (0%)
Louis Dreyfus	22,836	Europe (49.7%), Asia (29.5%), Northern America (15.5%), Oceania (4.5%), Africa (0.4%)	France (17.4%), United States of America (13.3%), Netherlands (12.9%), Japan (12.5%), United Kingdom (7.6%)	ING Groep NV (6.4%), BNP Paribas SA (4.5%), Societe Generale SA (4.4%), China Investment Corp (4.3%), Sas Rue La Boetie (4.2%)	Loan (91.8%), bond issuance (8.2%)

ETP risk company	Financial flows (2014 US$)	Top regions	Top countries	Top managing institutions	Top asset classes
Marfrig	10,797	Europe (37.9%), Latin America and the Caribbean (35.8%), Northern America (20.3%), Asia (5.9%)	Brazil (34.7%), United States of America (19.8%), United Kingdom (12.4%), Netherlands (10.2%), Spain (9.9%)	Banco Bradesco SA (12.9%), HSBC Holdings PLC (12.4%), Banco Santander SA (9.9%), Banco do Brasil SA (9.5%), BTG Pactual G7 Holding SA (7.5%)	Bond issuance (69.1%), loan (24.7%), equity issuance (6.2%)
Minerva	4,599	Latin America and the Caribbean (50.4%), Europe (23.8%), Northern America (23.1%), Asia (2.7%)	Brazil (45.1%), United States of America (23.1%), United Kingdom (14.8%), Cayman Islands (5.3%), Spain (5%)	IUPAR Itau Unibanco Participacoes SA (18.9%), HSBC Holdings PLC (14.8%), Banco Bradesco SA (12.2%), Bank of America Corp (12.1%), JPMorgan Chase & Co (9.7%)	Bond issuance (93.9%), equity issuance (6.1%)
Musim Mas	1,211	Europe (100%)	Netherlands (48.1%), France (29.5%), United Kingdom (22.4%)	Cooperatieve Rabobank UA (43.7%), Bpce SA (29.5%), HSBC Holdings PLC (22.4%), ING Groep NV (4.4%)	Loan (100%)
Permata Hijau	225	Asia (100%)	Indonesia (95.5%), Singapore (4.5%)	Bank Mandiri (Persero) Tbk PT (50.6%), Bank Rakyat Indonesia (Persero) Tbk PT (25.5%), Bank Negara Indonesia (Persero) Tbk PT (12.9%), Bank Pembangunan Daerah Jawa Barat dan Banten Tbk PT (6.6%), DBS Group Holdings Ltd (4.5%)	Loan (100%)
Royal Golden Eagle	6,804	Asia (79.7%), Europe (18.5%), Unknown (1.4%), Northern America (0.4%)	China (38%), Taiwan (26.8%), United Kingdom (9.6%), United Arab Emirates (4.4%), Hong Kong (3.3%)	China Investment Corp (13.6%), CITIC Group Corp (7.6%), Industrial and Commercial Bank of China Ltd (5.8%), NatWest Group PLC (5.7%), Taiwan Business Bank Ltd (3.9%)	Loan (97.2%), equity issuance (2.8%)
Sime Darby	1,238	Asia (66.7%), Europe (33.3%)	Japan (33.4%), Singapore (33.3%), United Kingdom (33.3%)	Oversea-Chinese Banking Corporation Ltd (33.3%), HSBC Holdings PLC (16.7%), Mitsubishi UFJ Financial Group Inc (16.7%), Mizuho Financial Group Inc (16.7%), Standard Chartered PLC (16.6%)	Loan (100%)
Sinar Mas	8,246	Asia (83.2%), Northern America (8%), Europe (5.3%), Oceania (2.3%), Unknown (1.2%)	Indonesia (66%), United States of America (8%), Malaysia (4.9%), Korea; Republic (S. Korea) (3.2%), Singapore (2.7%)	Bank Mandiri (Persero) Tbk PT (10%), Sinar Mas PT (9.9%), Nirmala Taruna PT (8%), Sucor Investama PT (7.9%), Dwimuria Investama Andalan PT (7.5%)	Bond issuance (68.6%), loan (23%), equity issuance (8.4%)
Wilmar	14,878	Asia (72.8%), Europe (18.9%), Oceania (5%), Northern America (3.3%)	China (23.4%), Singapore (14.6%), Japan (13.2%), Taiwan (8.3%), France (6%)	China Investment Corp (11.9%), China Securities Co Ltd (6.2%), DBS Group Holdings Ltd (5.7%), Oversea-Chinese Banking Corporation Ltd (5.1%), Mitsubishi UFJ Financial Group Inc (4.1%)	Loan (77.6%), equity issuance (15.7%), bond issuance (6.8%)

A3.2 Breakdown by type of finance

Use of proceeds

Table 6: Breakdown of financial flows by use of proceeds. The category, "sustainable finance label" is further broken down in the Table 7.

a) Brazilian Amazon

Primary use of proceeds	Amount (2014 US $m)	Proportion
General corporate purpose	367,631	73.7%
Refinancing	28,723	5.8%
Acquisitions/spinoffs	28,463	5.7%
Not disclosed	27,913	5.6%
Working capital	20,317	4.1%
Reduce indebtedness	9,020	1.8%
Payment on borrowings	4,069	0.8%
Trade finance	2,840	0.6%
Project finance	2,479	0.5%
Sustainable finance label	1,797	0.4%
Redeem class of shares	1,726	0.3%
Secondary	1,344	0.3%
Dividend recapitalization	992	0.2%
Other	796	0.2%
Capital expenditures	534	0.1%
Investment/loan to affiliate co	344	0.1%
Proceed to shareholders	100	0.0%

b) Indonesian peatlands

Primary use of proceeds	Amount (2014 US $m)	Proportion
General corporate purpose	44,862	66.9%
Working capital	8,594	12.8%
Capital expenditures	4,205	6.3%
Refinancing	2,589	3.9%
Acquisitions/spinoffs	2,183	3.3%
Sustainable finance label	1,133	1.7%
Not disclosed	1,061	1.6%
Secondary	639	1.0%
Payment on borrowings	474	0.7%
Relending	399	0.6%
Reduce indebtedness	366	0.5%
Other	210	0.3%
Trade finance	200	0.3%
Working fund	139	0.2%
Construction	27	0.0%

Sustainable finance

Table 7: Breakdown of financial flows tagged as sustainable by use-of-proceeds.

A) BRAZILIAN AMAZON

Primary use of proceeds	Amount (2014 US $m)	Proportion (sustainable flows)	Proportion (all flows)
General corporate purpose	20,075	80.40%	4.40%
Green bond purposes	490	2.00%	0.10%
Refinancing	1,726	6.90%	0.40%
Sustainability-linked	618	2.50%	0.10%
Trade finance	919	3.70%	0.20%
Transition bond purposes	456	1.80%	0.10%
Working capital	678	2.70%	0.10%

B) INDONESIA PEATLANDS

Primary use of proceeds	Amount (2014 US $m)	Proportion (sustainable flows)	Proportion (all flows)
General corporate purpose	1,855	48.80%	0.40%
Green bond purposes	467	12.30%	0.10%
Sustainability-linked	221	5.80%	0.00%
Trade finance	156	4.10%	0.00%
Working capital	1,105	29.00%	0.20%

Government ownership status

Table 8: Breakdown of financial flows by government ownership status.

A) BRAZILIAN AMAZON

Financial institution ownership	Amount (2014 US $m)	Proportion
Publicly listed or private	396,103	87.0%
State-owned	59,375	13.0%
Unknown	56	0.0%

B) INDONESIAN PEATLANDS

Financial institution ownership	Amount (2014 US $m)	Proportion
Publicly listed or private	47,321	78.5%
State-owned	12,496	20.7%
Unknown	430	0.7%

Country

Table 9: Breakdown of financial flows by financial institution country of headquarters.

A) BRAZILIAN AMAZON

Rank	Country of headquarters	Amount (2014 US$m)	Proportion
1	United States of America	101,518	22.3%
2	United Kingdom	44,329	9.7%
3	China	42,396	9.3%
4	France	35,251	7.7%
5	Japan	34,934	7.7%
6	Canada	30,785	6.8%
7	Netherlands	29,467	6.5%
8	Germany	22,290	4.9%
9	Australia	17,760	3.9%
10	Spain	17,643	3.9%
11	Brazil	14,159	3.1%
12	Switzerland	11,704	2.6%
13	Russia	11,010	2.4%
14	Singapore	10,444	2.3%
15	Italy	7,275	1.6%
16	Unknown	3,698	0.8%
17	Hong Kong	3,317	0.7%
18	United Arab Emirates	3,043	0.7%
19	Austria	2,420	0.5%
20	Sweden	2,284	0.5%
21	South Africa	2,116	0.5%
22	Belgium	1,541	0.3%
23	Bahrain	1,287	0.3%
24	Egypt	638	0.1%
25	Cayman Islands	609	0.1%
26	Taiwan	502	0.1%
27	Luxembourg	435	0.1%
28	Saudi Arabia	407	0.1%
29	Nigeria	320	0.1%
30	Norway	286	0.1%
31	Kuwait	250	0.1%
32	Chile	231	0.1%
33	Jordan	200	0.0%
34	Qatar	136	0.0%
35	Malaysia	134	0.0%
36	Portugal	127	0.0%
37	Gibraltar	122	0.0%
38	Korea; Republic (S. Korea)	117	0.0%
39	Philippines	97	0.0%
40	Ireland; Republic of	87	0.0%
41	India	61	0.0%
42	Israel	36	0.0%
43	Indonesia	31	0.0%
44	Poland	24	0.0%
45	Argentina	6	0.0%
46	Bangladesh	5	0.0%

B) INDONESIAN PEATLANDS

Rank	Country of headquarters	Amount (2014 US$m)	Proportion
1	Indonesia	10,113	16.8%
2	China	8,342	13.8%
3	Japan	7,377	12.2%
4	Singapore	7,092	11.8%
5	United Kingdom	5,942	9.9%
6	Taiwan	4,194	7.0%
7	Malaysia	3,558	5.9%
8	United Arab Emirates	2,184	3.6%
9	United States of America	1,975	3.3%
10	Australia	1,656	2.7%
11	France	1,511	2.5%
12	Netherlands	1,375	2.3%
13	Korea; Republic (S. Korea)	935	1.6%
14	Philippines	701	1.2%
15	Unknown	631	1.0%
16	Hong Kong	613	1.0%
17	Germany	418	0.7%
18	Switzerland	369	0.6%
19	India	315	0.5%
20	Bahrain	170	0.3%
21	Italy	148	0.2%
22	Kuwait	147	0.2%
23	Spain	120	0.2%
24	Guernsey	97	0.2%
25	Belgium	95	0.2%
26	Thailand	90	0.2%
27	Cyprus	77	0.1%

A3.3 Financial flows to ETP risk companies compared to annual flows

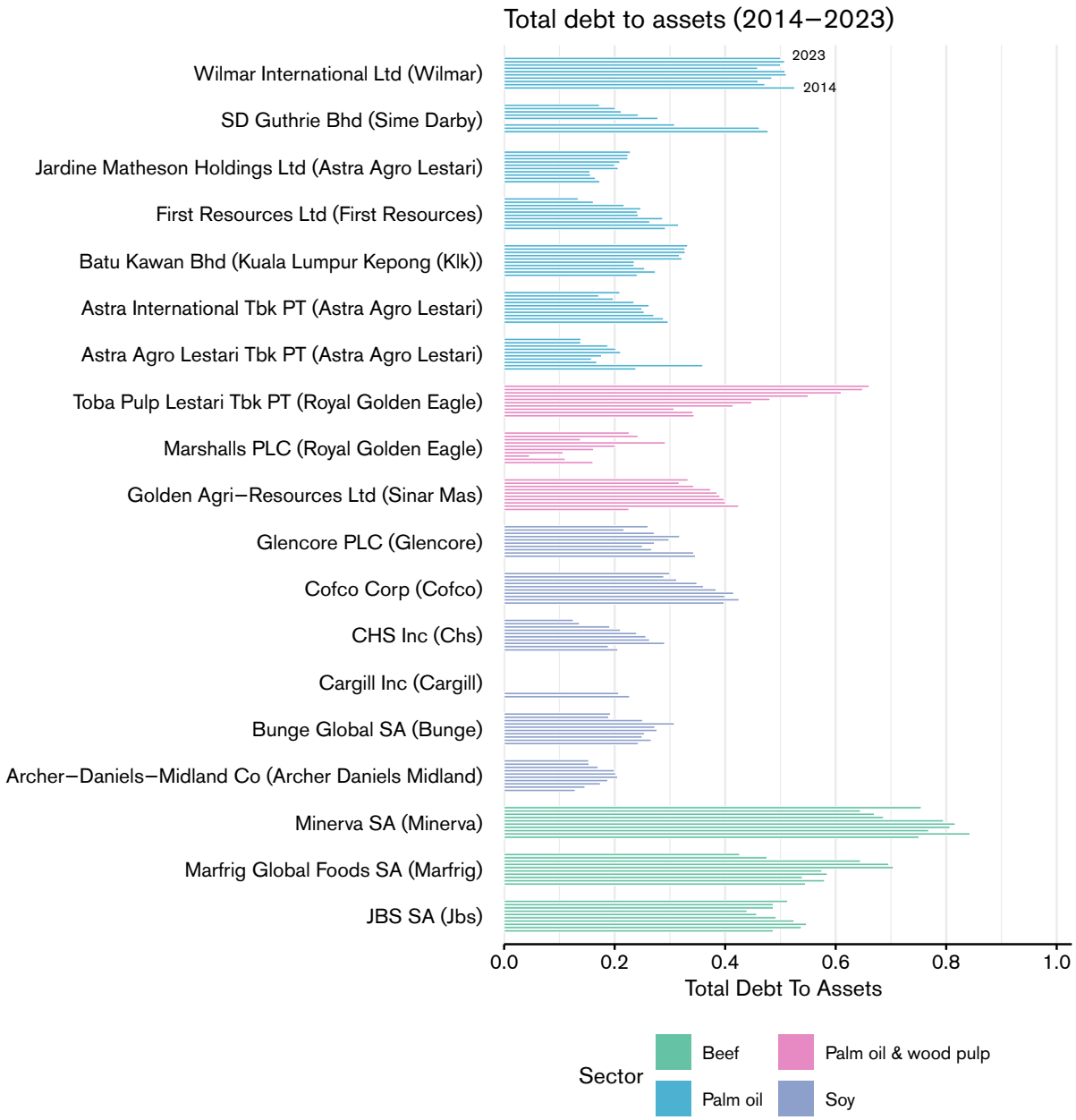
Table 10: Financial flows to ETP risk companies as a proportion of annual financial flows for top ten institutions for each ecosystem case, 2023.

Name	Financial flows to ETP risk companies (2023, US $m)	Overall financial flows (2023, US $m)	Proportion
China Investment Corp	1,897	949,113	0.20%
Citigroup Inc	3,634	524,652	0.69%
Bank of America Corp	3,689	671,117	0.55%
JPMorgan Chase & Co	2,851	671,493	0.42%
Barclays PLC	2,037	385,004	0.53%
HSBC Holdings PLC	2,030	303,277	0.67%
BNP Paribas SA	2,003	340,665	0.59%
Mitsubishi UFJ Financial Group Inc	1,459	257,522	0.57%
Deutsche Bank AG	1,368	309,263	0.44%
Cooperatieve Rabobank UA	1,331	42,283	3.15%
Mizuho Financial Group Inc	1,330	326,687	0.41%
Sumitomo Mitsui Financial Group Inc	1,177	285,100	0.41%
ING Groep NV	758	94,885	0.80%
DBS Group Holdings Ltd	806	31,535	2.56%
Oversea-Chinese Banking Corporation Ltd	637	10,643	5.99%
Bank Mandiri (Persero) Tbk PT	388	7,371	5.27%
CIMB Group Holdings Bhd	154	11,737	1.31%
Indo Premier Capital PT	406	854	47.53%

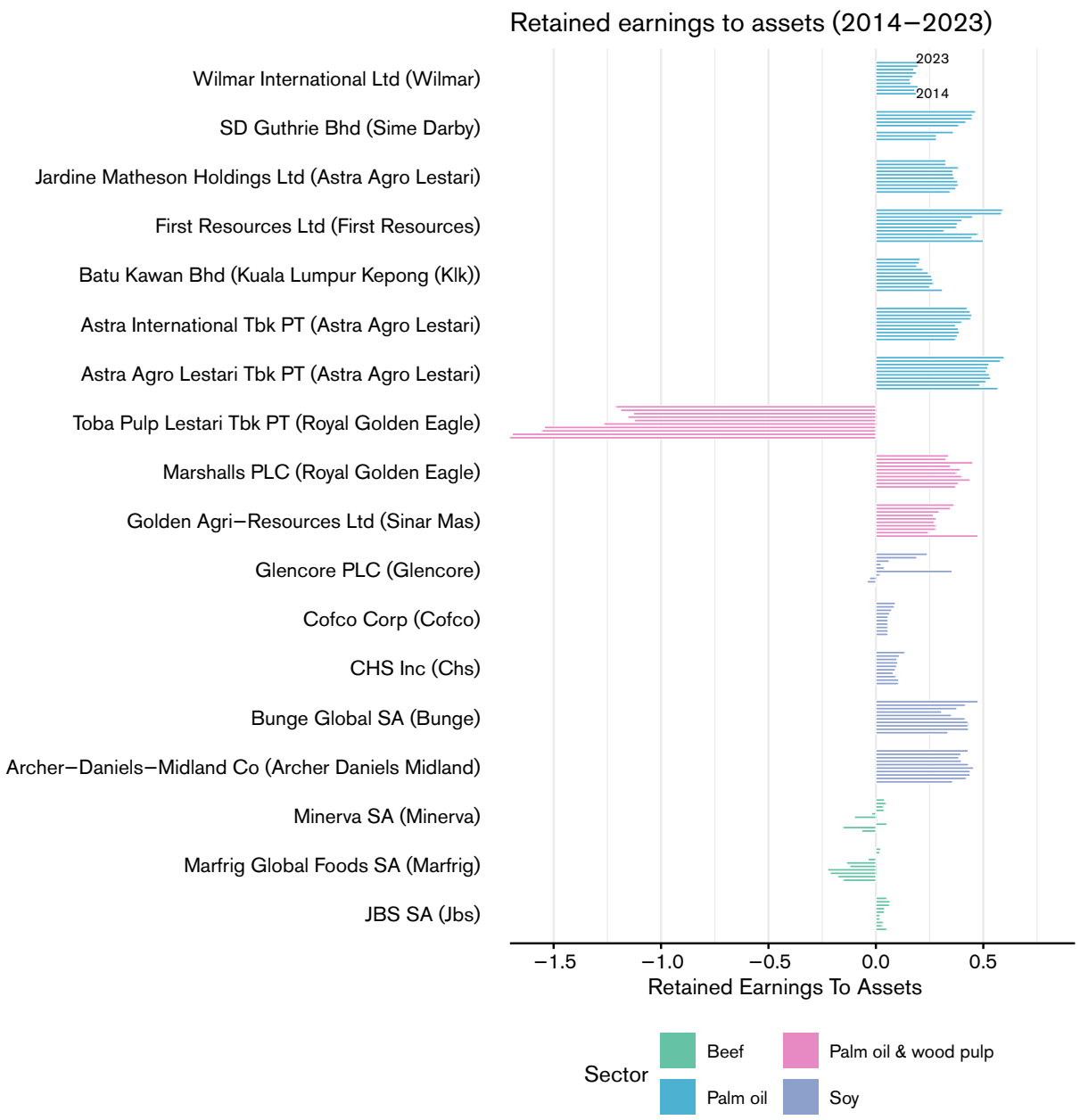
A4. Financial influence - additional data

Figure 11: Balance sheet ratios of legal entities of ETP risk companies over study period, 2014–2023.

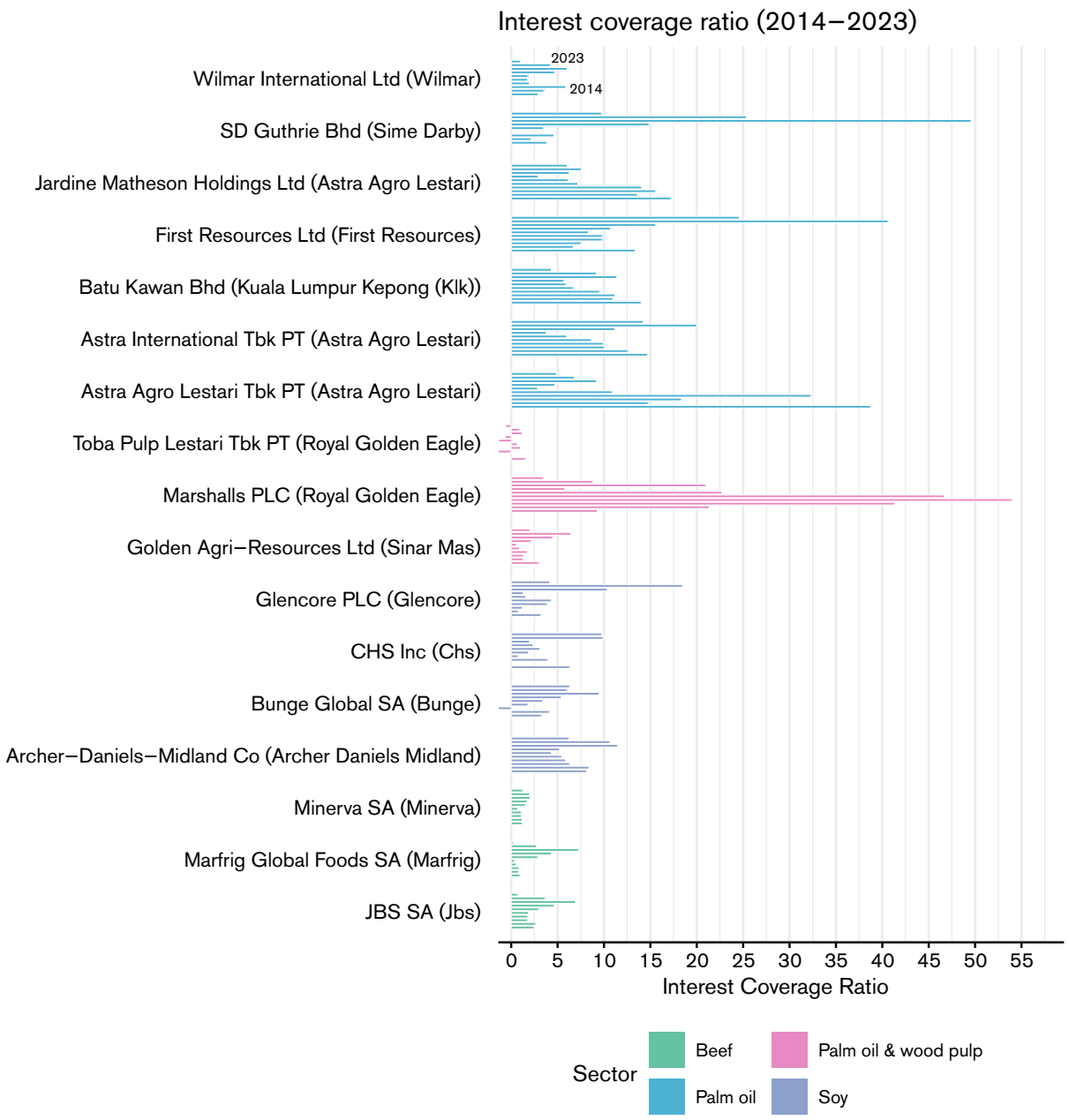
a)



b)


Retained earnings to assets (2014–2023)
Wilmar International Ltd (Wilmar)
SD Guthrie Bhd (Sime Darby)
Jardine Matheson Holdings Ltd (Astra Agro Lestari)
First Resources Ltd (First Resources)
Batu Kawan Bhd (Kuala Lumpur Kepong (Klk))
Astra International Tbk PT (Astra Agro Lestari)
Astra Agro Lestari Tbk PT (Astra Agro Lestari)
Toba Pulp Lestari Tbk PT (Royal Golden Eagle)
Marshalls PLC (Royal Golden Eagle)
Golden Agri–Resources Ltd (Sinar Mas)
Glencore PLC (Glencore)
Cofco Corp (Cofco)
CHS Inc (Chs)
Bunge Global SA (Bunge)
Archer–Daniels–Midland Co (Archer Daniels Midland)
Minerva SA (Minerva)
Marfrig Global Foods SA (Marfrig)
JBS SA (Jbs)
2023
2014
−1.5
−1.0
−0.5
0.0
0.5
Retained Earnings To Assets
Sector
Beef
Palm oil
Palm oil & wood pulp
Soy

c)


Interest coverage ratio (2014–2023)
2023
2014
Wilmar International Ltd (Wilmar)
SD Guthrie Bhd (Sime Darby)
Jardine Matheson Holdings Ltd (Astra Agro Lestari)
First Resources Ltd (First Resources)
Batu Kawan Bhd (Kuala Lumpur Kepong (Klk))
Astra International Tbk PT (Astra Agro Lestari)
Astra Agro Lestari Tbk PT (Astra Agro Lestari)
Toba Pulp Lestari Tbk PT (Royal Golden Eagle)
Marshalls PLC (Royal Golden Eagle)
Golden Agri–Resources Ltd (Sinar Mas)
Glencore PLC (Glencore)
CHS Inc (Chs)
Bunge Global SA (Bunge)
Archer–Daniels–Midland Co (Archer Daniels Midland)
Minerva SA (Minerva)
Marfrig Global Foods SA (Marfrig)
JBS SA (Jbs)
0 5 10 15 20 25 30 35 40 45 50 55
Interest Coverage Ratio
Sector
Beef
Palm oil
Palm oil & wood pulp
Soy

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