From financial risk to financial harm:
Exploring the agri-finance nexus and drivers of biodiversity loss

Katie Kedward
UCL Institute for Innovation and Public Purpose

Josh Ryan-Collins
UCL Institute for Innovation and Public Purpose

IIPP UCL Institute for Innovation and Public Purpose

WORKING PAPER
WP 2022/05

About the Institute for Innovation and Public Purpose

The UCL Institute for Innovation and Public Purpose (IIPP) aims to develop a new framework for creating, nurturing and evaluating public value in order to achieve economic growth that is more innovation-led, inclusive and sustainable.

We intend this framework to inform the debate about the direction of economic growth and the use of mission-oriented policies to confront social and technological problems. Our work will feed into innovation and industrial policy, financial reform, institutional change, and sustainable development.

A key pillar of IIPP's research is its understanding of markets as outcomes of the interactions between different actors. In this context, public policy should not be seen as simply fixing market failures but also as actively shaping and co-creating markets. Re-focusing and designing public organisations around mission-led, public purpose aims will help tackle the grand challenges facing the 21st century.

IIPP is housed in The Bartlett, a leading global Faculty of the Built Environment at University College London (UCL), with its radical thinking about space, design and sustainability.

This IIPP Working Paper Series is published electronically at https://www.ucl.ac.uk/bartlett/public-purpose/publications/working-papers.

ISSN 2635-0122

This report can be referenced as follows:

Kedward, K. and Ryan-Collins, J. (2022). *From financial risk to financial harm: exploring the agri-finance nexus and drivers of biodiversity loss.* UCL Institute for Innovation and Public Purpose, Working Paper Series (No. WP 2022/05). Available at: https://www.ucl.ac.uk/bartlett/public-purpose/wp2022-05

From financial risk to financial harm: Exploring the agri-finance nexus and drivers of biodiversity loss

Katie Kedward* and Josh Ryan-Collins**

Abstract

There is growing awareness amongst both financial policy makers and financial institutions of the need to better understand the links between the financial system and biodiversity loss. Central banks and financial supervisors have so far focused more on the risks posed by biodiversity loss to the financial system ("financial materiality") than the impacts of finance on biodiversity ("environmental materiality"). In the wider biodiversity-finance sphere, the emphasis has been on the creation of new financial products or investment opportunities associated with the restoration of nature or offsetting damages – so called 'nature-based solutions'. Less attention has been paid to the institutional relations that connect macro-financial and ecological systems and the growing importance of financial actors, incentives, and practices in shaping human demands upon the biosphere. In this context, we study the agri-finance nexus and find that finance-oriented practices such as maximizing agricultural land productivity, realising capital gains, and achieving scale are systemically associated with land use change and intensive agricultural practices that drive biodiversity loss and degradation. Importantly for policymakers, these findings indicate the financial sector to be indirectly contributing to the threat of breaching critical ecological tipping points, which would pose systemic macrofinancial risks. Central banks and supervisors should focus on their attention on encouraging the avoidance of such practices employing both monetary and (macro-)prudential policy toolkits. Given such activity falls outside the sphere of standard financial regulation, to do so will require greater coordination with other government departments, including environment agencies as well as international financial agencies.

Keywords: financial stability, financial regulation, macroprudential policy, central banks, environmental risks, biodiversity-related financial risks, environmental degradation, biodiversity loss, sustainable finance, systemic risk, land use, financialization, agri-finance

JEL codes: Q54, Q57, E44, E58, G28, G14

Acknowledgements:

An earlier, unpublished version of this paper was commissioned by and submitted to the NGFS-INSPIRE Study Group on Biodiversity and Financial Stability in November 2021. The research was supported by grants from Partners for a New Economy and the Laudes Foundation.

* Economist and Policy Fellow in Sustainable Finance, UCL Institute for Innovation and Public Purpose, k.kedward@ucl.ac.uk

** Head of Finance and Macroeconomics, UCL Institute for Innovation and Public Purpose, j.ryan-collins@ucl.ac.uk

1. Introduction: the rationale for focusing on the impacts of finance on biodiversity

Five direct drivers of biodiversity loss have been identified: land- and sea-use change, resource exploitation, climate change, pollution, and invasive species – all of which are linked to human industrial activities (IPBES, 2019). The direct and indirect financing of such activities needs to be reduced in order protect the biosphere. Central banks and financial supervisors are strongly placed to achieve such a shift in financial flows given their monetary and (macro)prudential policy remits. Indeed, these institutions have shown increasing interest in biodiversity loss in recent years; however the focus has been mainly upon the potential exposure of the financial system to activities associated with biodiversity drivers and the implications of such exposures on financial stability (NGFS, 2021; Svartzman et al., 2021; Van Toor et al., 2020). Less policy attention has been paid to the impacts of financial actors, practices and incentives on biodiversity loss.

One implication of this 'financial stability–oriented' approach is that unless such financial materiality can be demonstrated, it is not within the remit of financial policymakers to be concerned with how, why, and to what extent the financial system may be actively exacerbating – or mitigating – drivers of biodiversity loss. Since quantifying such exposures is very challenging given the fundamental uncertainty associated with biodiversity-related financial risks (Kedward et al 2020; Svartzman et al 2021), there is a risk that very little policy intervention mediating unsustainable financial flows will take place in the short term.

This problem has been recognised in recent years with the emergence of the concept of 'double materiality' (Adams et al., 2021; CDP et al., 2020; European Commission, 2019; TNFD, 2021). As well as direct financial impacts (financial materiality) of biodiversity loss, firms and financial institutions must also contend with the negative environmental impacts that result from their own business and financing activities – i.e., *environmental materiality* (Adams et al., 2021). Some also argue that evidence of environmental materiality should be itself sufficient evidence for financial actors, including policymakers, to act upon negative impacts associated with financing activities (Galaz et al., 2015; Scholtens, 2017). These perspectives go beyond considering the financial system as a passive intermediary of capital flows, responding only to pricing mechanisms, to recognise its considerable agency in shaping the direction of economic activity (Schumpeter, 1934; Campiglio, 2016; Ryan-Collins, 2019).

A key concern surrounds the continued financing of environmentally-harmful activities, which enables damaging stakeholders, technologies, and infrastructures to retain a persistently dominant position in the economy, making the transition to more ecologically-sustainable alternatives more difficult and costly – i.e., 'lock-in' effects (Galaz et al., 2018; Unruh, 2000). Indeed, the Dasgupta Review on the Economics of Biodiversity has noted that *'existing private financial flows that are adversely affecting the biosphere outstrip those that are enhancing natural assets, and there is a need to identify and reduce financial flows that directly harm and deplete natural assets'* (Dasgupta, 2021, p.474).

The direct drivers of biodiversity loss emerge from indirect drivers encompassing a range of socioeconomic factors, relating to demographics, culture, economic and market dynamics,

technologies, institutions, governance, conflicts, and epidemics (IPBES, 2019). Many of the identified indirect economic drivers, such as the rise of globalised supply chains and vertically integrated business models, coincide with the growing importance of the financial system within the global economy (Isakson, 2014a; Schmidt and Matthews, 2018). Financial actors, incentives, and practices need to be examined as factors implicated in these indirect drivers. For instance, a comparatively small number of multinational corporations dominate global commodity markets to the extent that they exert major influences on human interactions with major terrestrial, marine, atmospheric, and freshwater biomes (Folke et al., 2019). The financial system in turn may potentially exert significant influence on how such actors shape human-nature interactions (Galaz et al., 2018).

This paper takes the position that financial policymakers, including central banks, need to understand how the financial system impacts upon biodiversity not only due to the implications for financial stability, but also because such dynamics are relevant to understanding where and how aspects of finance may be undermining broader government policy goals on biodiversity. We therefore consider finance to be a critical component of the '*fundamental, system-wide reorganization across technological, economic and social factors, including paradigms, goals and values'* identified by the IPBES (2019) as necessary to reverse nature and biodiversity loss. This perspective also recognises that exploring how capital flows shape human-nature interactions offers the potential to identify 'sensitive intervention points' (Farmer et al., 2019) or 'positive tipping points' (Sharpe and Lenton, 2021) where financial policy interventions may encourage positive feedback loops that accelerate the transition to a more sustainable economy.

We illustrate these arguments in this paper through an examination of the role that finance plays in shaping human-nature interactions in the agricultural sector and specifically the financial market practices and drivers of biodiversity-negative land use change. We find that that standard financial practices – such as maximizing agricultural land productivity, realising capital gains, and achieving scale – are systemically associated with land use change and intensive agricultural practices that drive biodiversity loss and degradation. The financial risks posed to financial institutions by biodiversity loss (termed 'Biodiversity-related Financial Risks' (BRFR) should therefore be acknowledged as *endogenous*, given they emerge to a certain extent from institutional structures and dynamics within the financial system itself.

To address such endogenous risks, financial policymakers will need to go beyond the current focus on risk exposures and direct pricing mechanisms to also consider how financial(ised) institutional structures, incentives, and market practices affect capital allocation. We propose a 'precautionary financial policy' approach to biodiversity risks that emphasizes reduction in harmful business activities as a priority and consider how this may have stronger structural impact than private sector-led attempts to shift financial flows through 'nature-based solutions' and new financial instruments.

The remainder of this paper is structured as follows. In Section 2, we provide an overview of the current state of knowledge on the negative impacts of finance upon biodiversity and identify major knowledge gaps. In Section 3, we critically examine the emergence of new financial asset classes for nature restoration. Section 4 analyses the role that finance plays in shaping human-nature interactions in the agricultural sector. Section 5 further elaborates on the specific financial market

practices and drivers of biodiversity-negative land use change in the agricultural sector. Section 6 reflects upon the policy implications of our findings for central banks and financial supervisors and Section 7 concludes and identifies key questions for future research.

2. Quantifying the impacts of finance upon biodiversity

In recent years, there have been increased efforts by financial institutions and policymakers to quantify the negative impacts of the financial system upon biodiversity. Whilst methodologies remain in their infancy, considerable progress has been made in adapting tools designed to estimate corporate biodiversity 'footprints' for analysis of broader financial portfolios or whole jurisdictions (Berger et al., 2018; Lammerant et al., 2018).

One of the emerging tools used by central banks and financial supervisors is the Global Biodiversity Score (GBS) tool, developed by CDC Biodiversité and Carbon4 Finance. The tool uses a combination of peer-reviewed models[1] and proprietary databases to estimate corporate impacts upon biodiversity using the *Mean Species Abundance (MSA) per km²* metric to express the intactness of ecosystems (CDC Biodiversité, 2020). In the first such biodiversity impact assessment undertaken by a financial supervisor, the Dutch central bank *De Nederlandsche Bank (DNB)* calculated that the biodiversity footprint of Dutch financial institution equity exposures is comparable to the loss of 58,000 km² of pristine nature, an area equivalent to more than 1.7 times the land surface of the Netherlands (Van Toor et al., 2020). In a similar analysis that accounted for debt as well as equity instruments, researchers at the *Banque de France* estimated that financing activities by French financial institutions had caused to date a terrestrial biodiversity footprint comparable to the loss of 130,000km² of pristine nature, which is equivalent to 24% of the metropolitan area of France. Each year, French financial institutions were estimated to contribute to an additional 4,800km² of pristine nature loss (48 times the area of Paris). Land use change was identified as the main direct driver explaining these results, linked most prominently to the financing of sectors such as food product manufacture, chemicals, dairy, and gas (Svartzman et al., 2021).

Emerging footprint methodologies have key advantages for financial policymakers. These include the ability to generate footprint estimations from financial data, the relative ease of calculation and interpretation, and the potential to use the results to develop biodiversity-related scenario analysis (Svartzman et al., 2021). Yet several methodological limitations remain which warrant caution in interpreting and extrapolating from results. For the GBS tool, these include the fact that marine biodiversity is not accounted for; the pressure-impact relationships within the GLOBIO model are biased towards the most studied ecosystems and species; and the lack of locational specificity within the EXIOBASE3 input-output model, which sacrifices regional detail for sectoral definition (Lammerant et al., 2018; Svartzman et al., 2021). More broadly, footprint methodologies have also been challenged for relying on one metric to capture biodiversity, which may neglect the multidimensionality of biodiversity loss (Laurent and Owsianiak, 2017; Marques et al., 2021). At a

[1] Such as EXIOBASE3, an environmentally-extended multi-regional input-output model, and GLOBIO – a pressure-impact model developed by the PBL Environmental Agency of the Netherlands.

conceptual level, footprint metrics are also by definition aggregative, and hence conflict with an understanding of different aspects of nature being incommensurable and non-substitutable for each other (Spash and Hache, 2021).

A second category of empirical work has focused on tracing capital flows to particular sectors, companies, and locations, often accompanied by qualitative analysis of financial institution risk management processes, in order to estimate potential negative impacts resulting from financing activities. For instance, the DNB calculate that Dutch financial institutions have €15 billion in exposures to companies already active in environmentally-protected areas (Van Toor et al., 2020). Calice et al. (2021) find that 15% of Brazilian bank corporate loan portfolios are exposed to firms potentially operating in protected areas, and estimate that this exposure could increase to 38% should priority area conservation policy be deployed. Another study estimated that the European Central Bank potentially has up to €17.2 billion invested in companies that operate corporate facilities associated with negative impacts in areas of high biodiversity value where there has been significant habitat loss (Kedward et al., 2020). One advantage of approaches focusing on capital flows is that they can be focused upon activities affecting critical biomes, and hence generate insights into how financing activities are interacting with tipping point dynamics. Galaz et al. (2018) demonstrate an emerging approach, in this respect, identifying major financial actors with controlling influence in major corporations operating in the Amazon and Boreal Forest biomes.

Overall, empirical work so far provides an indicative view of the scale of contributions of different parts of the financial system to biodiversity loss. Policymakers today increasingly diagnose such ecologically damaging financial activity as a 'negative externality' – a function of the financial system mirroring the broader failure of the real economy to account for nature in its pricing and allocation of capital goods (Dasgupta, 2021). Accordingly, the most prominent proposed financial solutions (e.g., Deutz et al., 2020; TNFD, 2021) aim to influence prices through initiatives to increase the transparency of market information surrounding nature loss, whilst targeting capital reallocation through the development of novel risk assessment frameworks, more robust CSR-type policies, and new green financial asset classes. The deployment of financial instruments for nature restoration, in particular, positions financial actors, practices, and incentives as not only compatible with nature restoration goals, but able to substantially accelerate current efforts. We now examine these solutions in more detail.

3. New financial asset classes for nature restoration

It is estimated that the USD 133 billion per year currently invested into nature-based solutions (NBS) needs to triple by 2030 and quadruple by 2050 in order to meet climate mitigation and biodiversity restoration targets, and the private sector is currently assumed to be responsible for much of the investment shortfall (The Nature Conservancy, 2019; Deutz et al., 2020; UNEP, 2021; McKinsey and World Economic Forum, 2021). There are a wide variety of financial instruments under development, with most initiatives being led by the private sector. Table 1 depicts some examples of these, grouped by underlying purpose.

Table 1. Categories of green financial instruments.

PURPOSE	Financing the transition to green business activities	Investments in underlying ecosystems for carbon sequestration, conservation, or nature restoration purposes	Arbitrage instruments
INSTRUMENT	▪ Thematic private equity funds ▪ Green incubators, venture capital ▪ Green exchange-traded funds (ETFs) ▪ Green bonds and loans (use of proceeds for green activities) ▪ Sustainability-linked bonds and loans (green performance criteria levied on the issuer)	▪ Payments for ecosystem services ▪ REDD+[2] ▪ Debt-for-nature swaps ▪ Blended finance mechanisms ▪ Nature performance bonds	▪ Carbon offsets ▪ Biodiversity offsets ▪ Voluntary carbon markets ▪ Tradeable credits

Source: Authors

Financial authorities have been primarily involved in the first category of financial instruments, those focusing on investments in infrastructure or business process that relate to the sustainable use of ecosystem services. Whilst so far this involvement has focused on climate change, there are now moves to expand such efforts to nature. For example, the European Commission published in August 2021 an extension to its EU Sustainable Taxonomy that defines nature- and biodiversity-positive business activities. The ECB is also supporting the development of green debt instruments by accepting sustainability-linked bonds as collateral for access to central bank loans and is considering how to further support green bonds in its monetary policy operations (ECB, 2021). The Sustainable Taxonomy, however, has come under criticism for capture by corporate interests, resulting in the watering-down of definitions (e.g., fossil gas included in the taxonomy as a 'transition fuel') and in the failure to establish a taxonomy concurrently defining harmful activities (Varoufakis and Adler, 2020; Schreiber et al., 2020).

The design and development of the second and third categories of financial instruments has largely been left to the private sector – although financial institutions are now calling upon policymakers to use their policy toolkits to support the scale-up and establishment of these new green markets (The Nature Conservancy, 2019; Deutz et al., 2020; McKinsey and World Economic Forum, 2021). Yet critical questions remain about the effectiveness and appropriateness of these market-led approaches to mobilising finance for nature.

[2] Reduce Emissions from Deforestation and forest Degradation, and (+) foster conservation, sustainable management of forests, and enhancement of forest carbon stocks.

The second category of financial solutions in Table 2 relates to investments in the underlying ecosystems to ensure they are used for carbon sequestration, nature conservation, protection, or restoration purposes. Whilst these projects undoubtedly deliver significant economic benefits – wetlands restoration, for example, can provide flood defences, carbon sequestration, habitat for pollinators, amongst other ecosystem services – such 'returns' are not easily translated into the income streams required to attract investment capital (Chenet, 2019). Moreover, reversing nature and biodiversity loss also often requires alleviating the scale and intensity of human claims upon nature, which implies reduction in the most immediately profitable forms of economic activity.

Even where returns are tangible, nature restoration projects are a challenging sell for private investors. High transaction costs and returns that may take decades to materialise make for an unappealing risk-return profile, and the necessarily small and localised nature of many projects render them difficult and costly to incorporate into large-scale investment vehicles (Dempsey and Suarez, 2016; Chenet, 2019; Suttor-Sorel and Hercelin, 2020). Given the public good characteristics of many such projects, the role of private finance in primarily funding nature conservation and restoration is far less clear-cut than it is for climate mitigation. The care needed to ensure such novel instruments appropriately deliver on ecological outcomes whilst balancing the needs of all stakeholders may need far more financial policymaker oversight than is currently granted.

The third category of financial solutions refers to tradeable instruments whose function is to offset the impacts of environmentally harmful business activities (OECD, 2016) – for example, carbon credit markets – where firms purchase credits to offset their unavoidable emissions. Such instruments intersect both climate and biodiversity solutions, given that the schemes selling credits are usually linked to reforestation or afforestation projects with frequently cited biodiversity co-benefits (TSVCM, 2021).

Several problems with these schemes have been identified, including unresolved social justice issues (Ives and Bekessy, 2015), adverse implications on food security (Peña-Lévano et al., 2019), and little empirical evidence supporting the effectiveness of offset instruments in enhancing biodiversity and ecosystem health (May et al., 2017; Moilanen and Kotiaho, 2018; Hache, 2019a; zu Ermgassen et al., 2019). The various conceptual issues identified for carbon offset schemes, namely difficulties measuring and verifying true additionality, risks of leakage, and the impermanence of forest carbon (Hache, 2019b), are arguably exacerbated by the additional complexities and uncertainties involved in quantifying aspects of biodiversity.

It can be argued that offsets do not provide sufficient incentives for firms to align their business practices with the ecological transition given that paying for the right to damage or pollute can be considerably cheaper than changing entire nature-depleting or emissions-intensive business models (Spash, 2015; Spash and Hache, 2021). Relatedly, there are fears that offset credits are not being used in the appropriate context – defined by the mitigation hierarchy as the 'last resort' once all efforts to avoid, minimise, and restore damages have been taken (PWC, 2010). Others have recognised such issues, but maintain that offset markets can be improved through transparent standards and better governance and oversight mechanisms (Finance for Biodiversity and Climate Advisors, 2021).

Overall, despite these ongoing debates, central banks and financial supervisors have so far had little to do with the design or oversight of new financial asset classes, with the bulk of current initiatives remaining explicitly voluntary. Meanwhile regulatory involvement in the development of taxonomies has so far placed insufficient emphasis on the importance of defining and reducing harmful activities. Indeed, it is estimated that only a quarter of biodiversity-related finance needs to be directed towards conservation; the bulk of finance must instead be focused on mainstreaming the protection of biodiversity within economic sectors that affect it, such as agriculture, construction, and fishing (Deutz et al., 2020). This would suggest that policymakers should focus first and foremost on reducing and minimising flows of finance that are facilitating the most harmful business practices, as well as promoting major investments in alternative processes to help preserve jobs and sustainable forms of economic development.

A major knowledge gap concerns the incentives and institutional structures which lead financial actors to engage in biodiversity-negative activities. As economists from the Banque de France have noted: '*biodiversity protection cannot be solved simply by solving a theoretical investment gap: it also requires delving deeper into the nature of the relations between macrofinancial and ecological systems*' (Svartzman et al., 2021, p. 74). The Dasgupta Review on the Economics of Biodiversity has also emphasised the relevance of institutional failures, highlighting that: *'pricing and allocation of financial flows alone will not be sufficient to enable a sustainable engagement with Nature'* (Dasgupta, 2021, p. 467).

To address this knowledge gap, we now examine the nature of relations between the financial system and agriculture. The analysis focuses on financial practices in the 'agri-finance' nexus that give rise to negative impacts on biodiversity. In particular, we focus on the extent to which incentives, practices, and institutional dynamics stemming from the financial sector actively exacerbate drivers of biodiversity loss in critical biomes or 'natural capital assets' - the degradation of which may create systemic macro-financial risks.

4. Agri-financial linkages and increased commercial pressure on land

The agricultural sector is widely acknowledged to be a significant contributor to biodiversity loss: firstly, as the single largest driver of land use change, which leads to the loss and fragmentation of habitats, and secondly through negative environmental impacts resulting from agricultural intensification practices, such as pesticide and fertiliser use, freshwater withdrawals for irrigation, and energy-intensive mechanization (Benton et al., 2021; Campbell et al., 2017). By depleting soil fertility and freshwater availability, some agricultural intensification practices may also perversely drive further land use conversion to offset declining crop yields (Benton et al., 2021; Benton and Bailey, 2019). Productivity gains from agricultural intensification have been responsible for the vast majority of global crop yield increases over recent decades (Foley et al., 2011). But in tropical regions agricultural expansion and productivity enhancements have equally contributed to increased supply (Kastner et al., 2012; Rudel et al., 2009), and around 80% of new farmland is estimated to be created through deforestation (Gibbs et al., 2010; Sloan and Sayer, 2015). Such

land use change is of particular concern because tropical biomes are critical reservoirs of biodiversity and ecosystem services (Gibson et al., 2011), as well as having important bio-geophysical feedback effects on the global climate (Snyder et al., 2004). Indeed, forest biomes are increasingly recognised to be 'tipping elements' – the loss of which would significantly destabilise planetary processes (Lenton, 2013; Steffen et al., 2018).

The role of finance within agriculture has been a feature throughout the history of modern capitalism (Turvey, 2017), but agri-financial linkages have expanded and become more complex with the transition to modern industrial agricultural practices, and the liberalisation and globalisation of food commodity markets (Anseeuw et al., 2017; Ghosh, 2010). The global agri-food system is now characterised by a horizontally-concentrated and increasingly vertically-integrated market structure.[3] A handful of multinational firms dominate the processing, trade and retail of agri-commodities (Murphy, 2006) and have overseen the concentration of global calorie production around a limited set of highly productive commodities[4] that are best suited to globalized trade markets (Benton and Bailey, 2019; West et al., 2014).

It has been argued that the 'cheaper food paradigm' embedded in the modern food system – the drive to produce more food, and especially commodity crops, at lower costs through increasing inputs of land, water, energy, and agrochemicals – is largely responsible for the increased intensity and scale of land use for food production over recent decades (Benton et al., 2021). Empirical evidence supports this claim. For instance, most deforestation in tropical and subtropical regions is linked to expansion in commercial cropland, pastures, and tree plantations, and is particularly associated with key commodities (oil palm, soy and beef products) destined for export markets (Curtis et al., 2018; Pendrill et al., 2019). Indeed, the dynamics of global food markets have been demonstrated to be of particular empirical significance, with food consumption in high-income countries associated with *imported* biodiversity loss – i.e., imported food crops driving deforestation in low-income nations, and especially those located in tropical regions (Lenzen et al., 2012; Wilting et al., 2017).

The financial sector is implicated in the negative impacts of agriculture upon the biosphere through two mechanisms. Firstly, financial institutions effectively enable agricultural activities to take place through the provision of finance for capital expenditures (such as through loans, equity, and bonds) and through the provision of other financial services (such as advisory, underwriting, and insurance services), as well as financial instruments designed to mitigate the risks associated with unrealised profits (such as futures and options contracts). There are few studies of the links between financial flows and agricultural drivers of biodiversity loss but emerging research paints a picture of global financial interconnections mirroring consumption demand patterns for agricultural commodities. One study found that the world's largest 50 banks provided $380 billion of loans and equity/bond underwriting services to the agricultural sector, 20% of which is

[3] The global agri-food system is effectively 'hourglass' shaped – as millions of food producers and food consumers at either end of the food chain are connected by a dozen or so multinational agribusiness giants. It has been argued that this results in both oligopolistic and oligopsonistic market power effects, as the concentrated middle exerts huge influence over both food producers and food consumers (Thompson et al., 2007).

[4] Over 75% of the world's crop calories are derived from wheat, rice, maize, sugar, barley, soy, palm, and potato (West et al. 2014).

potentially associated with direct drivers of biodiversity loss. The banks with the largest exposure were mostly North American and European (Portfolio Earth, 2020). Another study mapped equity ownership data of key agricultural corporations operating in the Brazilian Amazon, and identified 16 'financial giants' with significant influence as common blockholders – most notable among them being the 'Big Three' passive investment managers: Blackrock, Vanguard, and State Street (Galaz et al., 2018). The Brazilian beef sector, in particular, is found to have substantial concentration of equity ownership in the hands of a few asset managers as well as reliance on external financing. This suggests a potentially crucial influence for large equity holders in mediating how these capital flows contribute to the emergence of known tipping elements in critical biomes.

The second mechanism by which the financial sector may be contributing to negative biodiversity impacts concerns the rise of agricultural land as an 'alternative' financial asset class over the past 20 years. From the data that is available, over 47 million hectares of large-scale land acquisitions (LSLAs) for agricultural purposes were transacted by non-domestic investors between 2000 and 2014 – a land area roughly the size of Spain – much of which took place in the Global South, and especially on the African continent (Anseeuw et al., 2012).[5] A range of empirical studies have linked LSLAs to increased commercial pressure on land in high-biodiversity–value tropical biomes, associated with both land intensification and extensification (including deforestation) (Davis et al., 2020, 2015; Giger et al., 2021; Mechiche-Alami et al., 2021; Messerli et al., 2014) – (see also Section 5).

Financial actors have been identified as prominent investors in LSLAs. In a spatial-temporal analysis of LSLAs taking place globally between 2000 and 2015, Mechiche-Alami et al. (2019) identify financial institutions and multinational agribusiness as the most dominant investor types, and agriculture as the primary investment intention, although with conservation and biofuels growing in importance throughout the period. Cross-country investment flow analysis reveals a global land trade network characterised by low- or middle-income countries effectively exporting their land investments to actors predominantly located in the Global North (Mechiche-Alami et al., 2019).

A range of different types of financial institutions have been identified as involved in LSLAs: investment banks, asset management companies, pension funds, insurance companies, sovereign wealth funds, development finance institutions, family offices, and endowment funds (Bergdolt and Mittal, 2012; Buxton et al., 2012; Humphreys et al., 2013; Ouma, 2014; Wijeratna et al., 2014). For these actors, agricultural land appeals as an 'alternative' asset class for two reasons: first, as a natural inflation hedge that has uncorrelated returns with broader equity markets; and secondly due to the fact that it is both a source of rents and capital gains (HighQuest Partners, 2010; Ouma, 2020). A common route to gain exposure is via investments in non-listed funds, such as those managed by private equity or investment trusts, which pool funds from multiple

[5] Large-scale land acquisitions are defined as the transfers of rights to own, use, or control land from smallholder communities to corporate actors through the sale, lease, or concession of areas larger than 200 hectares (Anseeuw et al., 2013). This is the definition used by the Land Matrix Initiative database (https://landmatrix.org) which is used by empirical papers cited in this section to source transaction data.

investors in order to buy up agricultural land either on 'own-and-lease-out' or 'own-and-operate' models[6] (Daniel, 2012; Fairbairn, 2014). In recent years, listed agricultural vehicles such as mutual funds and exchange-traded farmland funds have become increasingly available (Burwood-Taylor, 2014; Chong, 2020).[7]

The intercoupling of finance and agriculture has involved not just financial actors becoming linked to the management of agricultural land but also agribusiness corporates becoming involved in the provision of financial services for both productive and speculative purposes (Salerno, 2014). For instance, 16-17% of the capital for soy production in the Brazilian Cerrado region is provided by financial services divisions internal to multinational agribusiness traders (Sigles Robert and Tayleur, 2020). Moreover, the Big Four 'ABCD' commodity traders[8] offer a variety of sophisticated financial products to investors, including futures and swaps contracts for hedging and speculative purposes, commodity index funds, and private equity land investment vehicles (Murphy et al., 2012; Salerno, 2014). Other types of intermediary actors have also been identified as highly relevant to enabling and shaping this intercoupled 'agri-financial chain' (Anseeuw et al., 2017), including placement agents who market farmland prospects to investors, consultants providing due diligence and market information services, and state and multilateral institutions providing blended finance offerings on a 'de-risking' basis (Apampa et al., 2021; Daniel, 2012; Ducastel and Anseeuw, 2017).

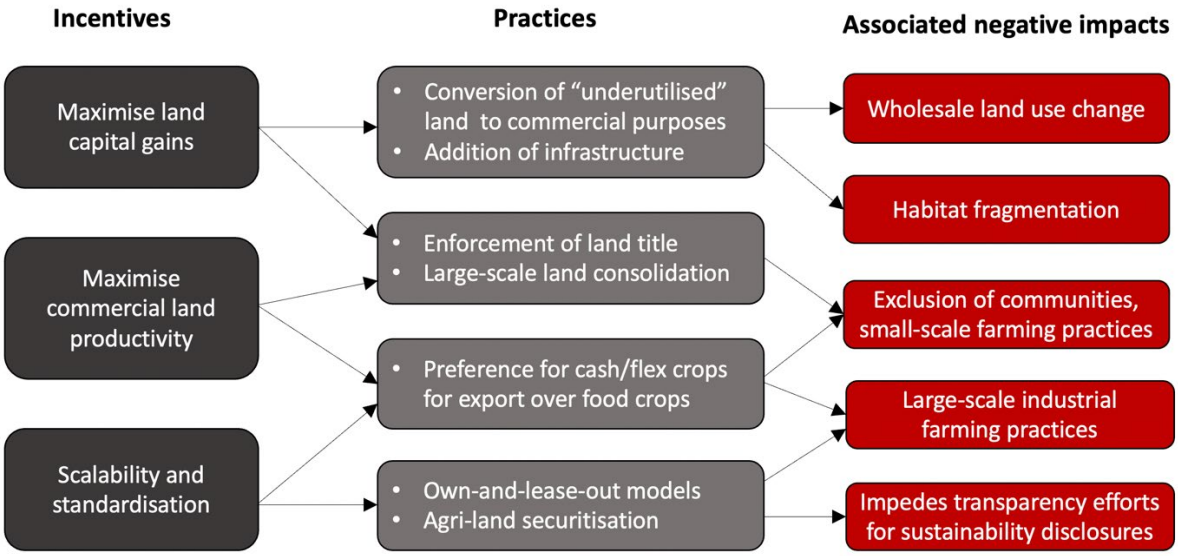
Overall, these findings indicate a complex global web of financial and non-financial actors interacting with agriculture at the tropical frontier for both speculative and productive purposes. Importantly, the emergence of farmland as an 'alternative' financial asset class has taken such exposures beyond the scope of traditional capital market structures. Additionally, the global and cross-sectoral dynamics at play indicate that processes of 'telecoupling' are highly relevant (Liu et al., 2015), whereby financial investment decisions may be generating cross-continental influences on distant social and ecological systems (Galaz et al., 2018).

5. Financial market practices and drivers of biodiversity-negative land use change

To what extent are negative biodiversity impacts resulting from land use change exacerbated by the import of financial incentives, practices, and mechanisms into the management of agricultural land? To answer this question, we focus on three types of financial incentives: (1) maximising capital gains on land holdings; (2) maximising the commercial productivity of land; and (3) ensuring that farmland investments are standardized and scalable. Figure 1 summarises the associations and relationships established in the theoretical, empirical and qualitative academic literature.

[6] Direct management of 'own-and-operate' investments is often undertaken by 'farmland investment management organisations' (FIMOs) (Fairbairn, 2014).
[7] Two such public funds include the Global Sustainable Farmland Income Trust (LSE:FARM); and Gladstone Land (NASDAQ:LAND), https://www.gladstonefarms.com.
[8] Archer Daniels Midland, Bunge, Cargill, and Louis Dreyfus are the most dominant agricultural commodities traders

Figure 1. Financial incentives and practices may actively exacerbate drivers of biodiversity loss



Source: Authors' own illustration

5.1 Maximising land capital gains

Farmland investment vehicles employ both 'own-operate' and 'own-and-lease-out' models. The latter is most aligned with the repositioning of agricultural land as a financial asset, as investors benefit from both rental income from farming tenants and the land's ability to store value over time. Yet, even for 'own-operate' investments, the real upside opportunities are in capital gains rather than agricultural income. First, cash returns from agriculture average around 5-7%, which is low compared to the equity market returns typically sought by institutional investors (Fairbairn, 2014). Second, financial actors themselves have identified the strong market fundamentals of land as its main investment appeal: namely, rising competition for land from urbanization, declining land quality, higher demand for meat products and hence animal feed, and strong commodity prices (Chong, 2020; HighQuest Partners, 2010).

Whilst land investments are typically used as long-term stores of value, some of the financial vehicles at play in the agricultural space have comparatively short investment horizons and must realise capital gains over that period (Daniel, 2012; Fairbairn, 2014). Private equity funds, for example, have a lifespan of 7-10 years and typically attract investors with an 'exit strategy' that demonstrates how the fund will actively generate value. Importantly, when applied to the agricultural space, such exit strategies imply active transformation of land holdings (AgriMoney, 2016). This typically includes: the addition of road or irrigation infrastructure, the clarification and enforcement of legal title, the consolidation of multiple small-holdings, or – more drastically – the conversion of natural ecosystems for commercial purposes (Fairbairn, 2014).

The empirical literature tends to support the association of these factors with large-scale land acquisitions. Focusing on LSLAs in Africa, Conigliani et al. (2018) find that the share of forest land in a country is a significant determinant of land acquisitions for commercial purposes, especially by international investors, indicating commercial pressure on Africa's forests. In an analysis of 80,000 land investments spanning 15 countries in Latin America, Southeast Asia, and

sub-Saharan Africa, Davis et al. (2020) find that LSLAs disproportionately target forested areas, and that over half were significantly associated with accelerated forest loss in the post-deal period, with the largest effects associated with export-oriented agricultural commodities. 34% of LSLAs where the precise location is known have been found to be close to or directly overlapping environmentally protected areas (Messerli et al., 2014), which would suggest that land investments also tend to target 'marginal' or underutilised but potentially productive lands. Case study literature has also explored negative environmental outcomes from active farmland transformation strategies. For example, Fairbairn et al. (2021) analysed how the Harvard Management Company installed intensive irrigation infrastructure and actively participated in local groundwater governance structures in order to cement water claims on their agricultural investments in the Cuyama Valley. Whilst such infrastructure increases the value of landholdings over the short term, it acutely exacerbated the critical situation of declining groundwater tables in the region.

These findings indicate that the incentive to monetize capital gains generates practices that may be misaligned with biodiversity-positive agricultural land management. As discussed in Section 3, the wholesale land use change and agricultural intensification that may result from these practices are linked to negative outcomes for biodiversity, and the significance of such impacts in tropical biomes may be especially destabilising for broader regional and planetary ecological processes. Additionally, as exemplified by the Harvard example, the import of financial short-termism resulting from short investment lifespans conflicts with the longer-term horizons required for sustainable treatment of water or soil resources.

5.2 Land productivity: maximising returns and minimising risks

Agricultural land values are largely based on the land's productivity, so maximising cash crop generation remains an important component of investment strategies even for value-generation–focused investors (Fairbairn, 2014). Investors in large-scale land acquisitions have typically aimed to achieve economies of scale by consolidating multiple small-holdings,[9] and targeting their acquisitions in productive but under-utilized lands – particularly in Africa – where there are higher gaps between actual and potential crop yields (Anseeuw et al., 2012).

One dimension by which the incentive to maximise land productivity may lead to negative biodiversity impacts is through choice of crops. Among private institutional investors employing 'own-and-operate' strategies, whether directly or through management companies, the literature reports a strong preference for so-called 'flex crops' that can be used for multiple purposes (Alonso-Fradejas et al., 2016; Bergdolt and Mittal, 2012; Borras et al., 2014; Genoud, 2018; HighQuest Partners, 2010; Isakson, 2014b).[10] These crops, which include soybean, sugarcane, palm oil, and corn, have flexible uses as either food, animal feed, or biofuel. It has been argued that such flexibility is especially beneficial as a diversification strategy within a financial portfolio:

[9] Note that the land deal data cited in the empirical studies in this paper all draw from the Land Matrix database, which defines LSLAs as transfers of rights from smallholder communities to corporate actors of areas larger than 200 hectares (Anseeuw et al., 2013).

[10] One study, albeit somewhat outdated, estimated that over 80% of farmland acquired by financial actors globally is allocated to produce major commodity crops corn, wheat, oil seed, and sugarcane (HighQuest, 2010).

crop uses can be rerouted depending on shifting profit forecasts, thereby minimising risk and increasing arbitrage opportunities within volatile commodity markets (Borras et al., 2014; Genoud, 2018). Some authors have argued that broader trends towards financialization within transnational agricultural corporations has led them to also expand within global flex crop markets (Alonso-Fradejas et al., 2016). As discussed in Section 3, export-oriented flex crops have been linked to negative biodiversity impacts resulting from both agricultural expansion and intensification (Benton et al., 2021; Davis et al., 2020).

The preference for export-oriented cash crops leads LSLA deals to often reallocate the most productive lands away from domestic food crop production, creating a high risk of land conflicts with local communities (Mechiche-Alami et al., 2021; Oberlack et al., 2016; Rulli and D'Odorico, 2014). A number of empirical studies have shown that weak local land rights and a high share of traditional rural tenure systems are significant determinants of LSLAs, suggesting that some of the ways investment strategies seek to add value may involve reducing access to local communities (Arezki et al., 2015; Conigliani et al., 2018; Dwyer, 2015; Giovannetti and Ticci, 2016). Whilst a full discussion of the social dynamics of LSLAs is beyond the scope of this paper, such social transitions are of relevance to considering biodiversity impacts. As well as potentially conflicting with the security of domestic food provision in acquisition countries, these findings also indicate a transition to more globalised and industrialised form of agriculture. By contrast, traditional, diversified farming systems (such as agroforestry) are marginalised, despite the fact that they are increasingly acknowledged to have better outcomes for biodiversity without necessarily compromising on food yields (Grass et al., 2020; Kremen et al., 2012; Tamburini et al., 2020).

Overall, the practices that are typical to financial investment vehicles aiming to maximise both productivity and underlying land values are not at present compatible with protecting and restoring these ecosystems or supporting the types of small-scale farming activities that may help restore nature whilst ensuring food security in critical biomes.

5.3 Scalability and standardisation

The economic feasibility of incorporating land-based investments into financial investment vehicles is strongly predicated upon achieving scalability and standardisation of individual investment opportunities. Scalability enables investors to diversify investment risk across geographies and markets, whilst standardisation minimises costs associated with management, monitoring, and due diligence. For instance, high transaction costs and the small, localised nature of investment opportunities has been identified as one of the key barriers impeding the scaling up of nature-based restoration and conservation projects into large-scale investment vehicles (Dempsey and Suarez, 2016; Deutz et al., 2020; Suttor-Sorel and Hercelin, 2020). Agricultural land, in particular, has substantial barriers to investment: farmland is not depreciable like other capital assets, and involves high fixed costs and lack of liquidity when compared to other investment opportunities.

Incentives towards scalability and standardisation hence provide further impetus for investment vehicles to pursue some of the practices already discussed: consolidation of multiple

smallholdings, own-and-lease-out models, and preferences for export-oriented flex crops. The more recent trend towards pooling multiple farmland holdings in 'real estate investment trust' (REIT)–style vehicles is another practice which enables investors to achieve diversification and cost minimisation through scale and standardization. It has been argued that these agri-funds, which are explicitly marketed on their enhanced liquidity and accessibility for retail investors (Burwood-Taylor, 2014; Chong, 2020), represent a move towards the securitisation of farmland, where the income streams of multiple agricultural investments are bundled into investment tranches to increase asset liquidity and tradability (Fairbairn, 2014).

However, practices aimed at scaling and standardising farmland investments may also inadvertently exacerbate negative drivers of biodiversity. The 'own-and-lease-out' strategies most commonly used by REIT-style funds result in the separation of land ownership from land management, effectively removing farmers' own stake in long-term productivity and hence reducing their incentives to deploy sustainable farming practices (Fairbairn, 2014). Where investors employ 'own-operate' strategies, incentives for sustainability may be eroded by comparatively short-term investment horizons and an overriding focus on realising returns on land appreciation through exit strategies, as already discussed.

Finally, there remain critical questions on how the financial practices discussed in this section can comply with emerging initiatives to increase the transparency of market practices through sustainability disclosures. A key barrier is that many relevant fund structures – most notably private equity – remain outside of the purview of traditional capital market regulation (Daniels, 2012). Securitised asset vehicles also face unique challenges in complying with ESG disclosure requirements, related to the complexity and opacity of tracing data associated with underlying assets (PRI, 2021). The need to manage informational asymmetries that may arise from agricultural investment vehicles and ensure there is sufficient market accountability for responsible fund allocation remains an urgent topic for future research. From a financial stability perspective, a critical research gap concerns how such off-balance sheet structures may propagate financial risks related to biodiversity loss throughout the financial system.

6. Discussion: implications for financial policy

Our exploration of the agri-financial linkages demonstrates how standard financial practices – such as maximizing agricultural land productivity, realising capital gains, and achieving scale – are systemically associated with land use change and intensive agricultural practices that drive biodiversity loss and degradation. In this sense, biodiversity-related financial risks may to a certain extent be *endogenous*, given that risks to the biosphere emerge to a certain extent from institutional structures and dynamics within the financial system itself. Endogenous risk has become an area of considerable focus for financial authorities since the 2007-08 crisis (Aikman et al., 2014; Borio, 2014). However, the focus has mainly been upon risks within the financial system and how shocks can be propagated across space and time due to the highly interconnected nature of the financial system. The relevance of finance-biosphere interactions demonstrated in this paper highlights that policy makers now need to focus their attention on another dimension of endogenous risk, involving institutional structures, incentives, and market

practices that affect capital allocation beyond direct pricing mechanisms - in other words, the institutional relations that connect macrofinancial and ecological systems. Resolving current negative dynamics may well require institutional and structural reforms that are unlikely to occur without serious policy interventions.

However, the negative impacts of financial flows do not only matter because they may eventually feedback through to the financial system. Given that finance has considerable agency in shaping the direction of economic activity, the continued financing of environmentally-harmful activities enables damaging stakeholders, technologies, and infrastructures to persist (i.e., 'lock-in effects'), and threatens to derail the trajectory of the transition to a more sustainable economy. Mitigating biodiversity-negative flows of finance is consequently an urgent task within the '*fundamental, system-wide reorganization across technological, economic and social factors, including paradigms, goals and values'* identified by the IPBES (2019) as necessary to reverse nature and biodiversity loss. Financial policymakers have an important role to play in using their policy toolkits to encourage an orderly transition of capital flows. There is a strong case for them to prioritize the *avoidance of harm* by the financial sector, before restoring and offsetting options are considered. The justifications are threefold.

Firstly, encouraging the implementation of a 'Do No Harm' principle for the financial system may be the simplest way for financial policymakers to fulfil their primary mandates to protect financial stability, given that the radical uncertainty of these risks impedes the use of conventional financial risk management tools (Kedward et al., 2020). This 'precautionary financial policy approach' (Chenet et al., 2021) could be seen as analogous to the 'mitigation hierarchy' framework used within some industrial sectors to limit negative impacts on biodiversity, where avoiding impacts are prioritised above more uncertain remediation and offsetting measures (Arlidge et al., 2018; Dempsey and Suarez, 2016; Lindenmayer et al., 2017; Watson et al., 2016).

Secondly, national and international policy priorities on preserving and restoring biodiversity are evolving at a rapid pace. The recent commitment at the COP26 conference towards ending deforestation by 2030, signed by 105 countries, is one such example. Shortly the post-2020 Global Biodiversity Framework (GBF) will be finalised at the COP15 in Kunming, China, setting out international targets to be achieved over the next decade. Given that many central banks and financial supervisors have explicit mandates to support sustainability, often through alignment with government policy objectives (Dikau and Volz, 2021), there is a strong case for financial policymakers to ensure that the financial sector is aligned with emerging biodiversity policy trajectories, as is the stated ambition with the Paris Agreement on Climate Change (art. 2.1(c)).

Thirdly, the financial system could be a strategic leverage point for accelerating a biodiversity-positive transition in the real economy (Farmer et al., 2019). Given that reversing biodiversity loss will require rapid divestment of certain damaging activities alongside major investments in alternative processes to help preserve jobs and sustainable forms of economic development, the strategic use of financial policies may enable such a capital reallocation challenge to be accelerated in a more orderly fashion. In other words, regulatory tools have 'market-shaping' potential to minimise the potential destabilising impacts of unpredictable transition risks (Ryan-Collins, 2019).

To operationalise a precautionary financial policy approach for biodiversity, financial policymakers, working in collaboration with the relevant environmental regulators, should establish a public taxonomy of biodiversity-harmful activities where financing activities either need to be restricted or subject to enhanced due diligence. A combination of approaches could be used to define the list of excluded practices, such as the existence of clear scientific consensus, national policy direction, or the forthcoming Post-2020 Global Biodiversity Framework, once finalised. To encourage swift deployment, policymakers could focus initially on sectors most implicated in the direct drivers of biodiversity loss, such as agriculture and mining (UNEP-WCMC, 2020), and harmful practices taking place in critical biomes (e.g., coral reefs, rainforest, and tundra) - the loss of which would substantially contribute to the threat of breaching tipping points (Mace et al., 2014). Financial policymakers should then use their policy toolkits to disincentivise or prohibit the financing of negative activities through, for example, the use of prudential regulation or more overt credit guidance type restrictions. Financial supervisors could also mandate financial institutions to adopt an 'exclusionary approach' when evaluating the impacts of their investments, whereby they are required to prioritise the reduction of their portfolio exposures to biodiversity-harmful activities over and above the use of offset-type instruments. Additionally, monetary policy tools, such as asset purchase programmes and collateral operations, could exclude assets linked to such activities.

As demonstrated by complex linkages within the agri-finance nexus, a complicating factor is that many of the endogenous risks created by the financial sector are taking place beyond the purview of conventional capital market or banking regulatory structures. Furthermore, the diverse actors involved are often beyond the usual (domestic) jurisdictions of financial supervisors and regulators. The implementation of an exclusionary and precautionary financial policy approach therefore requires careful collaboration between central banks, financial supervisors, ministries of finance and other relevant government agencies. Whilst central banks cannot take a lead in determining the pathway of transition within the agricultural sector, for example, there may be a financial stability case for extending financial regulation to 'shadow banking' activities undertaken by agri-giants and their off-balance sheet activities. Similarly, where there is clear scientific consensus of harm regarding a particular financing activity, central banks may have a 'precautionary' justification for moving ahead of established government policy to take immediate policy action for financial risk mitigation. Exploring the legal, institutional, and practical implications of these questions would be a worthy avenue for future analysis.

7. Conclusion and further research

Central banks and financial supervisors have focused their interventions in regard to the environment on improving the ability of financial markets to discover and account for environment-related financial risks to the financial sector itself. In the wider biodiversity-finance sphere, attention has been focused on the creation of new financial products or investment opportunities to accelerate the restoration of nature or to offset unavoidable damages. In this paper, we have argued that neither approach will be sufficient to address biodiversity-related financial risks. Policy attention also needs to focus on examining the impact of financial practices and financial flows on

the degradation of nature and ecosystems as a key form of environmental materiality. This is because the continued depletion of the biosphere will lead to ecological tipping points with systemic and potentially catastrophic macro-financial impacts. This makes it relevant to present central bank and financial supervisory mandates.

Our case study of agri-financial linkages demonstrates the key role of financial practices in contributing to biodiversity loss, including in key biomes such as rainforests. We argue that central banks and supervisors should focus on their attention on encouraging the avoidance of such practices. One way to do this would be via engagement with 'mitigation hierarchy'-type programs which fully account for the potential benefits of development not taking place, as opposed to remediation or offsetting efforts. This could be an important intervention since currently the private financial sector seems more focused on the latter types of financing interventions.

This paper reveals a number of areas which require further research. Firstly, there is a need for more focused empirical work on the origination of financial flows negatively impacting critical natural capital assets or biomes such as rainforests or boreal forests. This will give financial policy makers a better understanding of which types of domestic intervention may be most effective in preventing the crossing of ecological tipping points and also help them consider which international partners require engaging. Working in collaboration with organisations such as the International Monetary Fund and the Bank of International Settlements on this agenda would seem appropriate given their global focus.

Secondly, there is a need to extend empirical work beyond domestic jurisdictions to better understand cross-border financial flows linked to drivers of biodiversity loss. One promising avenue could be the multi-regional biodiversity footprint analysis that can explore which jurisdictions may be net importers or exporters of biodiversity-harmful finance – extending existing work on the significance of cross-border trade flows in this respect (Wilting et al., 2017). Relatedly, financial policymakers could also investigate the biodiversity impacts of more complex cross-border financial instruments, such as trade finance and supply chain finance, and the potential for greening these mechanisms to support a biodiversity-positive transition (Sigles Robert and Tayleur, 2020). Finally, given the high level of complexity and uncertainty around biodiversity loss, we would encourage central banks to consider closer collaboration with ecologists and other related scientific experts.

References

Adams, C. A., Alhamood, A., He, X., Tian, J., Wang, L., and Wang, Y. (2021). The Double-Materiality Concept: Application and Issues. Global Reporting Initiative.

AgriMoney. (2016). How to find the exit from agricultural investments. 2 June 2016. https://farmlandgrab.org/26192.

Aikman, D., Haldane, A. G., and Nelson, B. D. (2014). Curbing the credit cycle. The Economic Journal 125. https://doi.org/10.1111/ecoj.12113,

Alonso-Fradejas, A., Liu, J., Salerno, T., and Xu, Y. (2016). Inquiring into the political economy of oil palm as a global flex crop. null 43, 141–165. https://doi.org/10.1080/03066150.2015.1052801.

Anseeuw, W., Boche, M., Breu, T., Giger, M., Lay, J., Messerli, P., and Nolte, K. (2012). Transnational land deals for agriculture in the global South, Analytical Report Based on the Land Matrix Database. CDE, CIRAD, GIGA, Bern, Montpellier, Hamburg.

Anseeuw, W., Lay, J., Messerli, P., Giger, M., and Taylor, M. (2013). Creating a public tool to assess and promote transparency in global land deals: the experience of the Land Matrix. null 40, 521–530. https://doi.org/10.1080/03066150.2013.803071.

Anseeuw, W., Roda, J.-M., Ducastel, A., and Kamaruddin, N. (2017). Global Strategies of Firms and the Financialization of Agriculture, in: Biénabe, E., Rival, A., Loeillet, D. (Eds.), Sustainable Development and Tropical Agri-Chains. Springer Netherlands, Dordrecht, pp. 321–337. https://doi.org/10.1007/978-94-024-1016-7_25.

Apampa, A., Clubb, C., Cosgrove, B., et al. (2021). Scaling up critical finance for sustainable food systems through blended finance (Discussion Paper). CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS).

Arezki, R., Deininger, K., and Selod, H. (2015). What Drives the Global "Land Rush"? The World Bank Economic Review 29, 207–233. https://doi.org/10.1093/wber/lht034.

Arlidge, W. N., Bull, J. W., Addison, P. F., Burgass, M. J., Gianuca, D., Gorham, T. M., Jacob, C., Shumway, N., Sinclair, S. P., and Watson, J. E. (2018). A global mitigation hierarchy for nature conservation. BioScience 68, 336–347.

Benton, T., Bieg, C., Harwatt, H., Pudasaini, R., and Wellesley, L. (2021). Food system impacts on biodiversity loss: Three levers for food system transformation in support of nature (Research Paper). Chatham House.

Benton, T. G., and Bailey, R. (2019). The paradox of productivity: agricultural productivity promotes food system inefficiency. Global Sustainability 2, e6. https://doi.org/10.1017/sus.2019.3

Bergdolt, C., and Mittal, A. (2012). Betting on World Agriculture. US Private Equity Managers Eye Agricultural Returns. Oakland Institute, Oakland, USA.

Berger, J., Goedkoop, M. J., Broer, W., et al. (2018). Common Ground in Biodiversity Footprint Methodologies for the Financial Sector (Working Paper No. 12). Actiam, ASN Bank, CDC Biodiversité, Paris.

Borio, C. (2014). The financial cycle and macroeconomics: What have we learnt? Journal of Banking & Finance 45, 182–198.

Borras, S., Franco, J., Isakson, R., Levidowq, L., and Vervest, P. (2014). Towards Understanding the Politics of Flex Crops and Commodities: Implications for Research and Policy Advocacy (Think Piece Series on Flex Crops & Commodities). Transnational Institute.

Burwood-Taylor, L. (2014). Agri REITs will mobilise the masses, says ex-Rabo head. Agri-Investor. https://www.agriinvestor.com/agri-reits-will-mobilise-masses-says-ex-rabo-head/.

Buxton, A., Campanale, M., and Cotula, L. (2012). Farms and funds: investment funds in the global land rush (IIED Briefing). International Institute for Environment and Development.

Calice, P., Diaz Kalan, F., and Miguel, F. (2021). Nature-Related Financial Risks in Brazil (Policy Research Working Paper No. 9759). World Bank.

Campbell, B. M., Beare, D. J., Bennett, E. M., et al. (2017). Agriculture production as a major driver of the Earth system exceeding planetary boundaries. Ecology and Society 22. https://doi.org/10.5751/ES-09595-220408.

Campiglio, E. (2016). Beyond carbon pricing: The role of banking and monetary policy in financing the transition to a low-carbon economy. Ecological Economics 121, 220–230. https://doi.org/10.1016/j.ecolecon.2015.03.020.

CDC Biodiversité. (2020). The Global Biodiversity Score. The BGS Review: Core Concepts.

CDP, CDSB, GRI, IIRC, SASB. (2020). Reporting on enterprise value: Illustrated with a prototype climate-related financial disclosure standard.

Chenet, H. (2019). *Planetary Health and the Global Financial System*. Rockefeller Foundation Economic Council on Planetary Health.

Chenet, H., Ryan-Collins, J. and Lerven, F. van. (2021). Finance, climate-change and radical uncertainty: Towards a precautionary approach to financial policy. *Ecological Economics*. 183,106957.

Chong, F. (2020). Agriculture: Rising liquidity. IPE Real Assets. https://realassets.ipe.com/forestry-/-agri/agriculture-rising-liquidity/10044030.article.

Conigliani, C., Cuffaro, N., and D'Agostino, G. (2018). Large-scale land investments and forests in Africa. Land Use Policy 75, 651–660. https://doi.org/10.1016/j.landusepol.2018.02.005.

Curtis, P.G., Slay, C. M., Harris, N. L., Tyukavina, A., and Hansen, M. C. (2018). Classifying drivers of global forest loss. Science 361, 1108. https://doi.org/10.1126/science.aau3445.

Daniel, S. (2012). Situating private equity capital in the land grab debate. The Journal of Peasant Studies, l 39, 703–729. https://doi.org/10.1080/03066150.2012.674941.

Dasgupta, P. (2021). The economics of biodiversity: The dasgupta review. HM Treasury, London.

Davis, K. F., Koo, H. I., Dell'Angelo, J., D'Odorico, P., Estes, L., Kehoe, L. J., Kharratzadeh, M., Kuemmerle, T., Machava, D., Pais, A. de J. R., Ribeiro, N., Rulli, M. C., and Tatlhego, M. (2020). Tropical forest loss enhanced by large-scale land acquisitions. Nature Geoscience 13, 482–488. https://doi.org/10.1038/s41561-020-0592-3.

Davis, K. F., Yu, K., Rulli, M. C., Pichdara, L., D'Odorico, P. (2015). Accelerated deforestation driven by large-scale land acquisitions in Cambodia. Nature Geoscience 8, 772–775. https://doi.org/10.1038/ngeo2540.

Dempsey, J., Suarez, D. C. (2016). Arrested Development? The Promises and Paradoxes of "Selling Nature to Save It." null 106, 653–671. https://doi.org/10.1080/24694452.2016.1140018.

Deutz, A., Heal, G., Niu, R., and Swanson, E. (2020). Financing Nature: Closing the global biodiversity financing gap. The Paulson Institute, The Nature Conservancy, and the Cornell Atkinson Center for Sustainability.

Dikau, S., and Volz, U. (2021). Central bank mandates, sustainability objectives and the promotion of green finance. Ecological Economics 184, 107022. https://doi.org/10.1016/j.ecolecon.2021.107022.

Ducastel, A., and Anseeuw, W. (2017). Agriculture as an asset class: reshaping the South African farming sector. Agriculture and Human Values 34, 199–209. https://doi.org/10.1007/s10460-016-9683-6.

Dwyer, M. B. (2015). The formalization fix? Land titling, land concessions and the politics of spatial transparency in Cambodia. null 42, 903–928. https://doi.org/10.1080/03066150.2014.994510.

ECB. (2021). ECB presents action plan to include climate change considerations in its monetary policy strategy. *Press Release*. [Online]. Available from: https://www.ecb.europa.eu/press/pr/date/2021/html/ecb.pr210708_1~f104919225.en.html.

European Commission. (2019). Guidelines on reporting climate-related information (No. C(2019) 4490). Brussels.

Fairbairn, M. (2014). 'Like gold with yield': evolving intersections between farmland and finance. The Journal of Peasant Studies 41, 777–795. https://doi.org/10.1080/03066150.2013.873977.

Fairbairn, M., LaChance, J., De Master, K. T., and Ashwood, L. (2021). In vino veritas, in aqua lucrum: Farmland investment, environmental uncertainty, and groundwater access in California's Cuyama Valley. Agriculture and Human Values 38, 285–299. https://doi.org/10.1007/s10460-020-10157-y.

Farmer, J. D., Hepburn, C., Ives, M. C., Hale, T., Wetzer, T., Mealy, P., Rafaty, R., Srivastav, S., and Way, R. (2019). Sensitive intervention points in the post-carbon transition. Science 364, 132. https://doi.org/10.1126/science.aaw7287.

Finance for Biodiversity and Climate Advisors. (2021). Governing Voluntary Carbon Markets: Enhancing the ability of the TSVCM to contribute to climate goals [Online]. Available from: https://a1be08a4-d8fb-4c22-9e4a-2b2f4cb7e41d.filesusr.com/ugd/643e85_3074eefec66d433e803b901d423e2c19.pdf.

Foley, J. A., Ramankutty, N., and Brauman, K. A., et al. (2011). Solutions for a cultivated planet. Nature 478, 337–342. https://doi.org/10.1038/nature10452.

Folke, C., Österblom, H., Jouffray, J.-B., et al. (2019). Transnational corporations and the challenge of biosphere stewardship. Nature Ecology & Evolution 3, 1396–1403. https://doi.org/10.1038/s41559-019-0978-z.

Galaz, V., Crona, B., Dauriach, A., Scholtens, B., and Steffen, W. (2018). Finance and the Earth system – Exploring the links between financial actors and non-linear changes in the climate system. Global Environmental Change 53, 296–302. https://doi.org/10.1016/j.gloenvcha.2018.09.008.

Galaz, V., Gars, J., Moberg, F., Nykvist, B., and Repinski, C. (2015). Why Ecologists Should Care about Financial Markets. Trends in Ecology & Evolution 30, 571–580. https://doi.org/10.1016/j.tree.2015.06.015.

Genoud, C. (2018). Flex crops neverland: finding access to large-scale land investments? null 15, 685–701. https://doi.org/10.1080/14747731.2018.1488655.

Ghosh, J. (2010). The Unnatural Coupling: Food and Global Finance. Journal of Agrarian Change 10, 72–86. https://doi.org/10.1111/j.1471-0366.2009.00249.x.

Gibbs, H. K., Ruesch, A. S., Achard, F., Clayton, M. K., Holmgren, P., Ramankutty, N., and Foley, J. A. (2010). Tropical forests were the primary sources of new agricultural land in the 1980s and 1990s. Proc Natl Acad Sci USA 107, 16732. https://doi.org/10.1073/pnas.0910275107.

Gibson, L., Lee, T. M., Koh, L. P., et al. (2011). Primary forests are irreplaceable for sustaining tropical biodiversity. Nature 478, 378–381. https://doi.org/10.1038/nature10425.

Giger, M., Eckert, S., and Lay, J. (2021). Large-scale land acquisitions, agricultural trade, and zoonotic diseases: Overlooked links. One Earth 4, 605–608. https://doi.org/10.1016/j.oneear.2021.04.020.

Giovannetti, G., and Ticci, E. (2016). Determinants of biofuel-oriented land acquisitions in Sub-Saharan Africa. Renewable and Sustainable Energy Reviews 54, 678–687. https://doi.org/10.1016/j.rser.2015.10.008.

Grass, I., Kubitza, C., Krishna, V. V., Corre, M. D., et al. (2020). Trade-offs between multifunctionality and profit in tropical smallholder landscapes. Nature Communications 11, 1186. https://doi.org/10.1038/s41467-020-15013-5.

Gros, D. (2020). The Dangerous Allure of Green Central Banking. Project Syndicate.

Hache, F. (2019a). 50 Shades of Green: The Fallacy of Environmental Markets (Policy Report). Green Finance Observatory.

Hache, F. (2019b). *50 Shades of Green: The rise of natural capital markets and sustainable finance. Part 1: Carbon* [Online]. Green Finance Observatory. Available from: https://greenfinanceobservatory.org/wp-content/uploads/2019/03/50-shades-carbon-final.pdf.

HighQuest Partners. (2010). Private Financial Sector Investment in Farmland and Agricultural Infrastructure (OECD Food, Agriculture and Fisheries Papers No. No. 33). OECD, Paris.

Humphreys, J., Solomon, A., and Tumusiime, E. (2013). US Investment in Large-Scale Land Aquisitions in Low- and Middle Income Countries. Oxfam, Washington, D.C.

IPBES. (2019). The global assessment report on Biodiveristy and Ecosytem Services: Summary for Policymakers. Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES).

Isakson, S.R. (2014a). Food and finance: The financial transformation of agro-food supply chains. The Journal of Peasant Studies 41, 749–775.

Isakson, S.R. (2014b). Food and finance: the financial transformation of agro-food supply chains. null 41, 749–775. https://doi.org/10.1080/03066150.2013.874340.

Ives, C. D., and Bekessy, S. A. (2015). The ethics of offsetting nature. Frontiers in Ecology and the Environment 13, 568–573. https://doi.org/10.1890/150021.

Kastner, T., Rivas, M. J. I., Koch, W., and Nonhebel, S. (2012). Global changes in diets and the consequences for land requirements for food. Proc Natl Acad Sci USA 109, 6868. https://doi.org/10.1073/pnas.1117054109.

Kedward, K., Ryan-Collins, J., and Chenet, H. (2021). Understanding the financial risks of nature loss: exploring policy options for financial authorities (No. 115), SUERF Policy Briefs. SUERF: The European Money and Finance Forum.

Kedward, K., Ryan-Collins, J., and Chenet, H. (2020). Managing nature-related financial risks: a precautionary policy approach for central banks and financial supervisors. (Working Paper No. IIPP WP 2020-09). UCL Institute for Innovation and Public Purpose.

Kremen, C., Iles, A., and Bacon, C. (2012). Diversified Farming Systems: An Agroecological, Systems-Based Alternative to Modern Industrial Agriculture. Ecology and Society 17.

Lammerant, J., Müller, L., and Kisielewicz, J. (2018). Critical assessment of assessment of biodiversity biodiversity accounting accounting approaches for approaches for businesses businesses and financial institutions. European Commission and Business @ Biodiversity.

Laurent, A., and Owsianiak, M. (2017). Potentials and limitations of footprints for gauging environmental sustainability. Current Opinion in Environmental Sustainability 25, 20–27. https://doi.org/10.1016/j.cosust.2017.04.003.

Lenton, T. M. (2013). Environmental tipping points. Annual Review of Environment and Resources 38, 1–29.

Lenzen, M., Moran, D., Kanemoto, K., Foran, B., Lobefaro, L., and Geschke, A. (2012). International trade drives biodiversity threats in developing nations. Nature 486, 109–112. https://doi.org/10.1038/nature11145.

Lindenmayer, D. B., Crane, M., Evans, M. C., Maron, M., Gibbons, P., Bekessy, S., and Blanchard, W. (2017). The anatomy of a failed offset. Biological Conservation 210, 286–292.

Liu, J., Hull, V., Luo, J., Yang, W., and Wei, L. (2015). Multiple telecouplings and their complex interrelationships. Ecology and Society 2, 44.

Mace, G. M., Reyers, B., Alkemade, R., et al. (2014). Approaches to defining a planetary boundary for biodiversity. Global Environmental Change 28, 289–297. https://doi.org/10.1016/j.gloenvcha.2014.07.009.

Marques, A., Robuchon, M., Hellweg, S., et al. (2021). A research perspective towards a more complete biodiversity footprint: a report from the World Biodiversity Forum. The International Journal of Life Cycle Assessment 26, 238–243. https://doi.org/10.1007/s11367-020-01846-1.

May, J., Hobbs, R. J., and Valentine, L. E. (2017). Are offsets effective? An evaluation of recent environmental offsets in Western Australia. Biological Conservation 206, 249–257. https://doi.org/10.1016/j.biocon.2016.11.038.

McKinsey, World Economic Forum. (2021). Nature and Net Zero. Available from: http://www3.weforum.org/docs/WEF_Consultation_Nature_and_Net_Zero_2021.pdf.

Mechiche-Alami, A., Piccardi, C., Nicholas, K. A., and Seaquist, J. W. (2019). Transnational land acquisitions beyond the food and financial crises. Environmental Research Letters 14, 084021. https://doi.org/10.1088/1748-9326/ab2e4b.

Mechiche-Alami, A., Yagoubi, J., and Nicholas, K. A. (2021). Agricultural land acquisitions unlikely to address the food security needs of African countries. World Development 141, 105384. https://doi.org/10.1016/j.worlddev.2020.105384.

Messerli, P., Giger, M., Dwyer, M. B., Breu, T., and Eckert, S. (2014). The geography of large-scale land acquisitions: Analysing socio-ecological patterns of target contexts in the global South. Applied Geography 53, 449–459. https://doi.org/10.1016/j.apgeog.2014.07.005.

Moilanen, A., and Kotiaho, J. (2018). Planning biodiversity offsets: twelve operationally important decisions. Nordic Council of Ministers.

Murphy, S. (2006). Concentrated Market Power and Agricultural Trade (Ecofair Trade Dialogue Discussion Paper).

Murphy, S., Burch, D., and Clapp, J. (2012). Cereal Secrets: The world's largest grain traders and global agriculture (Oxfam Research Reports). OXFAM.

NGFS. (2021). Biodiversity and financial stability: exploring the case for action (Occasional Paper). Network for Greening the Financial System.

Oberlack, C., Tejada, L., Messerli, P., Rist, S., and Giger, M. (2016). Sustainable livelihoods in the global land rush? Archetypes of livelihood vulnerability and sustainability potentials. Global Environmental Change 41, 153–171. https://doi.org/10.1016/j.gloenvcha.2016.10.001.

OECD. (2016). *Biodiversity Offsets: Effective Design and Implementation* [Online]. OECD. Available from: https://www.oecd.org/env/biodiversity-offsets-9789264222519-en.htm.

Ouma, S. (2020). Farming as Financial Asset: Global Finance and the Making of Institutional Landscapes. Agenda Publishing, Newcastle.

Ouma, S. (2014). Situating global finance in the Land Rush Debate: A critical review. Geoforum 57, 162–166. https://doi.org/10.1016/j.geoforum.2014.09.006.

Peña-Lévano, L.M., Taheripour, F., and Tyner, W.E. (2019). Climate Change Interactions with Agriculture, Forestry Sequestration, and Food Security. Environmental and Resource Economics 74, 653–675. https://doi.org/10.1007/s10640-019-00339-6.

Pendrill, F., Persson, U. M., Godar, J., and Kastner, T. (2019). Deforestation displaced: trade in forest-risk commodities and the prospects for a global forest transition. Environmental Research Letters 14, 055003.

Portfolio Earth. (2020). Bankrolling Extinction: The Banking Sector's Role in the Global Biodiversity Crisis.

PRI, (2021). ESG incorporation in securitised products: The challenges ahead. Principles for Responsible Investment, UNEP Finance Initiative, UN Global Compact.

PWC. (2010). *Biodiversity offsets and the mitigation hierarchy: a review of current application in the banking sector* [Online]. Available from: https://www.unepfi.org/fileadmin/documents/biodiversity_offsets.pdf.

Rudel, T. K., Schneider, L., Uriarte, M., et al. (2009). Agricultural intensification and changes in cultivated areas, 1970–2005. Proc Natl Acad Sci USA 106, 20675. https://doi.org/10.1073/pnas.0812540106.

Rulli, M.C., and D'Odorico, P. (2014). Food appropriation through large scale land acquisitions. Environmental Research Letters 9, 064030. https://doi.org/10.1088/1748-9326/9/6/064030.

Ryan-Collins, J. (2019). Beyond voluntary disclosure: why a "market-shaping" approach to financial regulation is needed to meet the challenge of climate change (SUERF Policy Note No. Issue No. 61). SUERF: The European Money and Finance Forum.

Salerno, T. (2014). Capitalising on the financialisation of agriculture: Cargill's land investment techniques in the Philippines. null 35, 1709–1727. https://doi.org/10.1080/01436597.2014.971567.

Schmidt, J. J., Matthews, N. (2018). From state to system: Financialization and the water-energy-food-climate nexus. Geoforum 91, 151–159.

Scholtens, B. (2017). Why Finance Should Care about Ecology. Trends in Ecology & Evolution 32, 500–505. https://doi.org/10.1016/j.tree.2017.03.013.

Schreiber, P., Pinson, L., and Can Ileri, E. (2020). *In the shadows: who is opposing the EU taxonomy for polluting activities* [Online]. Reclaim Finance. Available from: https://reclaimfinance.org/site/wp-content/uploads/2020/12/Report-In-the-shadows-Who-is-opposing-a-taxonomy-for-polluting-activities-Reclaim-Finance.pdf.

Schumpeter, J. A. (1934). The theory of economic development: an inquiry into profits, capital, credit, interest, and the business cycle, Social science classics series. Transaction Books, New Brunswick, N.J.

Sharpe, S., and Lenton, T. M. (2021). Upward-scaling tipping cascades to meet climate goals: plausible grounds for hope. Climate Policy 1–13. https://doi.org/10.1080/14693062.2020.1870097.

Sigles Robert, J., and Tayleur, C. (2020). Combating deforestation linked to the soy industry: The role of traders and banks involved in the Brazil-China soy supply chain. University of Cambridge Institute for Sustainability Leadership, Business & Nature.

Sloan, S., and Sayer, J. A. (2015). Forest Resources Assessment of 2015 shows positive global trends but forest loss and degradation persist in poor tropical countries. Forest Ecology and Management 352, 134–145. https://doi.org/10.1016/j.foreco.2015.06.013.

Snyder, P. K., Delire, C., and Foley, J. A. (2004). Evaluating the influence of different vegetation biomes on the global climate. Climate Dynamics 23, 279–302. https://doi.org/10.1007/s00382-004-0430-0.

Spash, C. L. (2015). Bulldozing biodiversity: The economics of offsets and trading-in Nature. *Biological Conservation*. 192, pp.541–551.

Spash, C. L., Hache, F. (2021). The Dasgupta Review deconstructed: an exposé of biodiversity economics. null 1–24. https://doi.org/10.1080/14747731.2021.1929007.

Steffen, W., Rockström, J., Richardson, K., et al. (2018). Trajectories of the Earth System in the Anthropocene. Proc Natl Acad Sci USA 115, 8252. https://doi.org/10.1073/pnas.1810141115.

Suttor-Sorel, L., and Hercelin, N. (2020). Nature's Return Embedding environmental goals at the heart of economic and financial decision-making. Finance Watch.

Svartzman, R., Espagne, E., Gauthey, J., Hadji-Lazaro, P., Salin, M., Allen, T., Berger, J., Calas, J., Godin, A., and Vallier, A. (2021). A "Silent Spring" for the Financial System? Exploring Biodiversity-Related Financial Risks in France (Working Paper No. 826). Banque de France.

Tamburini, G., Bommarco, R., Wanger, T., Kremen, C., van der Heijden, M., Liebman, M., and Hallin, S. (2020). Agricultural diversification promotes multiple ecosystem services without compromising yield. Science Advances 6. https://doi.org/10.1126/sciadv.aba1715.

The Nature Conservancy. (2019). Investing in Nature: Private finance for nature-based resilience. Available from: https://www.nature.org/content/dam/tnc/nature/en/documents/TNC-INVESTING-IN-NATURE_Report_01.pdf.

Thompson, J., Millstone, E., Scoones, I., Ely, A., Marshall, F., Shah, E., and Stagl, S. (2007). Agri-food System Dynamics: pathways to sustainability in an era of uncertainty (STEPS Working Paper No. 4). STEPS Centre, Institute of Development Studies, University of Sussex.

TNFD. (2021). Nature in Scope: A summary of the proposed scope, governance, work plan, communication and resourcing plan of the TNFD. Taskforce on Nature-related Financial Disclosures.

TSVCM. (2021). Scaling Voluntary Carbon Markets: Phase II Report [Online]. Taskforce on Scaling Voluntary Carbon Markets. Available from: https://www.iif.com/Portals/1/Files/TSVCM_Phase_2_Report.pdf.

Turvey, C. G. (2017). Historical developments in agricultural finance and the genesis of America's farm credit system. Agricultural Finance Review 77, 4–21. https://doi.org/10.1108/AFR-09-2016-0076.

UNEP. (2021). *State of Finance for Nature: Tripling investments in nature-based solutions by 2030* [Online]. United Nations Environment Programme. Available from: https://www.unep.org/resources/state-finance-nature.

UNEP-WCMC. (2020). Beyond "Business as Usual": Biodiversity Targets and Finance. Managing biodiversity risks across business sectors. UN Environment Programe World Conservation Monitoring Centre.

Unruh, G.C. (2000). Understanding carbon lock-in. Energy Policy 28, 817–830. https://doi.org/10.1016/S0301-4215(00)00070-7.

Van Toor, J., Piljic, D., and Schellekens, G. (2020). Indebted to nature Exploring biodiversity risks for the Dutch financial sector. De Nederlandsche Bank.

Varoufakis, Y., and Adler, D. (2020). The EU's green deal is a colossal exercise in greenwashing. *The Guardian*.

Watson, J. E., Shanahan, D. F., Di Marco, M., Allan, J., Laurance, W. F., Sanderson, E. W., Mackey, B., and Venter, O. (2016). Catastrophic declines in wilderness areas undermine global environment targets. Current Biology 26, 2929–2934.

West, P., Gerber J. S., Engstrom P. M., et al. (2014). Leverage points for improving global food security and the environment. Science 345, 325–328. https://doi.org/10.1126/science.1246067.

Wijeratna, A., Chandrasekaran, K., and Lowe, S. (2014). What's Your Pension Funding? How UK Institutional Investors Finance the Global Land Grab. Friends of the Earth, London.

Wilting, H. C., Schipper, A. M., Bakkenes, M., Meijer, J. R., and Huijbregts, M. A. J. (2017). Quantifying Biodiversity Losses Due to Human Consumption: A Global-Scale Footprint Analysis. Environ. Sci. Technol. 51, 3298–3306. https://doi.org/10.1021/acs.est.6b05296.

Zu Ermgassen, S.O.S.E., Baker, J., Griffiths, R. A., Strange, N., Struebig, M. J., and Bull, J. W. (2019). The ecological outcomes of biodiversity offsets under "no net loss" policies: A global review. Conservation Letters 12, e12664. https://doi.org/10.1111/conl.12664.

The IIPP Working Paper series and Policy Reports

IIPP WP 2017-01 Mission-Oriented innovation policy: Challenges and opportunities. Mariana Mazzucato.

IIPP WP 2017-02 Thinking about technology policy: 'Market Failures' versus 'Innovation systems'. Richard R Nelson.

IIPP WP 2017-03 Technological capacity in the public sector: the Case of Estonia. Veiko Lember, Rainer Kattel, Piret Tõnurist.

IIPP WP 2017-04 Rethinking value in health Innovation: From mystification towards prescriptions. Mariana Mazzucato, Victor Roy.

IIPP WP 2017-05 Patient strategic finance: Opportunities for state investment banks in the UK. Mariana Mazzucato, Laurie Macfarlane.

IIPP WP 2018-01 State investment banks and patient finance: An international comparison. Laurie Macfarlane, Mariana Mazzucato.

IIPP WP 2018-02 Putting austerity to bed: Technical progress, aggregate demand and the supermultiplier. Matteo Deleidi, Mariana Mazzucato.

IIPP WP 2018-03 The bit and the rainforest: Towards the evolutionary theory of policy capacity. Erkki Karo, Rainer Kattel

IIPP WP 2018-04 Financing green growth. Semieniuk Gregor, Mariana Mazzucato.

IIPP WP 2018-05 Mission-oriented innovation policy and dynamic capabilities in the public sector. Rainer Kattel, Mariana Mazzucato.

IIPP WP 2018-06 The economics of change: Policy and appraisal for missions, market shaping and public purpose. Rainer Kattel, Mariana Mazzucato, Josh Ryan-Collins, Simon Sharpe.

IIPP WP 2018-07 Movements with missions make markets. Charles Leadbeater.

IIPP WP 2018-08 Bringing the helicopter to ground: A historical review of fiscal-monetary coordination to support economic growth in the 20th century. Josh Ryan-Collins, Frank van Lerven.

IIPP WP 2018-09 Estonia's digital transformation: Mission mystique and the hiding hand. Rainer Kattel, Ines Mergel.

IIPP WP 2018-10 The people's prescription: Re-imagining health innovation to deliver public health. UCL Institute for Innovation and Public Purpose, Stop Aids, Just Treatment, Global Justice Now.

IIPP WP 2018-11 Credit where it's due: A historical, theoretical and empirical review of credit guidance policies in the 20th century. Dirk Bezemer, Josh Ryan-Collins, Frank van Lerven and Lu Zhang.

IIPP WP 2019-01 Supermultiplier, innovation and the ecosystem: A stock-flow dynamic model. Matteo Deleidi, Riccardo Pariboni, Marco Veronese Passarella.

IIPP WP 2019-02 A mission-oriented framework for the Scottish National Investment Bank. Mariana Mazzucato, Laurie Macfarlane.

IIPP WP 2019-03 A framework for mission-oriented innovation policy roadmapping for the SDGs. Mariana Mazzucato, Laurie Macfarlane.

IIPP WP 2019-04 A Mission-Oriented UK Industrial Strategy. UCL Commission for Mission-Oriented Innovation and Industrial Strategy (MOIIS).

IIPP WP 2019-05 Putting value creation back into 'public value': From market fixing to market shaping. Mariana Mazzucato, Josh Ryan-Collins.

IIPP WP 2019-06 The macroeconomic impact of government innovation policies: A quantitative assessment. Matteo Deleidi, Vicenzo De Lipsis, Mariana Mazzucato, Josh Ryan-Collins, Paolo Agnolucci.

IIPP WP 2019-07 Financial and legal barriers to the creation and operation of a British national investment bank. Rob Calvert Jump, Natalya Naqvi.

IIPP WP 2019-08 Public investment fiscal multipliers: An empirical assessment for European countries. Matteo Deleidi, Francesca Iafrate, Enrico Sergio Levrero.

IIPP WP 2019-09 Socialising the risks and rewards of public investments: Economic, policy and legal issues. Andrea Laplane, Mariana Mazzucato.

IIPP WP 2019-10 Neither crowding in nor out: Public direct investment mobilising private investment into renewable electricity projects. Matteo Deleidi, Mariana Mazzucato, Gregor Semieniuk.

IIPP WP 2019-11 Social structures of accumulation in Greece, 1980-2014. Angeliki Papadopoulou, Giorgos Gouzoulis.

IIPP WP 2019-12 Innovation bureaucracies: How agile stability creates the entrepreneurial state. Rainer Kattel, Wolfgang Drechsler, Erkki Karo.

IIPP WP 2019-13 Climate-related financial policy in a world of radical uncertainty: Towards a precautionary approach. Hugues Chenet, Josh Ryan-Collins, Frank van Lerven.

IIPP WP 2020-01 The public economy: Understanding government as a producer. June Sekera.

IIPP WP 2020-02 The entrepreneurial (welfare) state? Tackling social issues through challenge prizes. Ville Takala, Emma Nordbäck and Tuukka Toivonen.

IIPP WP 2020-03 Determinants of income shares and the stable middle in post-socialist China. Giorgos Gouzoulis, Collin Constantine.

IIPP WP 2020-04 Industrial policy: A long-term perspective and overview of theoretical arguments Erik S. Reinert.

IIPP WP 2020-05 Gig work at the base of the pyramid: considering dependence and control. Kate Roll.

IIPP WP 2020-06 Deindustrialisation reconsidered: Structural shifts and sectoral heterogeneity. Fiona Tregenna, Antonio Andreoni.

IIPP WP 2020-07 Upward-scaling tipping cascades to meet climate goals: Plausible grounds for hope. Simon Sharpe, Timothy Lenton.

IIPP WP 2020-08 When homes earn more than jobs: the rentierization of the Australian housing market. Josh Ryan-Collins, Cameron Murray.

IIPP WP 2020-09 Managing nature-related financial risks: a precautionary policy approach for central banks and financial supervisors. Katie Kedward, Josh Ryan-Collins, Hugues Chenet.

IIPP WP 2020-10 Welfare 5.0: Why we need a social revolution and how to make it happen. Hilary Cottam.

IIPP WP 2020-11 Public value and platform governance. Mariana Mazzucato, Josh Entsminger, Rainer Kattel.

IIPP WP 2020-12 COVID-19 and public-sector capacity. Mariana Mazzucato, Rainer Kattel.

IIPP WP 2020-13 Theorising and mapping modern economic rents. Mariana Mazzucato, Josh Ryan-Collins, Giorgos Gouzoulis.

IIPP WP 2020-14 Missioni Italia. Mariana Mazzucato.

IIPP WP 2020-15 Schumpeter, the entrepreneurial State and China. Leonardo Burlamaqui.

IIPP WP 2020-16 Public wealth funds: Supporting economic recovery and sustainable growth. Dag Detter, Stefan Fölster, Josh Ryan-Collins.

IIPP WP 2020-17 The EIB and the new EU missions framework. Mariana Mazzucato, Olga Mikheeva.

IIPP WP 2020-19 Creating and measuring dynamic public value at the BBC. Mariana Mazzucato, Rowan Conway, Eleonora Maria Mazzoli, Eva Knoll, Sarah Albala.

IIPP WP 2020-20 The entrepreneurial State and public options: socialising risks and rewards. Mariana Mazzucato, Henry Lishi Li.

IIPP WP 2020-21 A market-shaping approach for the biopharmaceutical industry: governing innovation towards the public interest. Mariana Mazzucato, Henry Lishi Li.

IIPP WP 2021/01 Dynamic capabilities in the public sector: The case of the UK's Government Digital Service. Rainer Kattel, Ville Takala.

IIPP WP 2021/02 Innovations in development finance and conditioning factors: BNDES and the fostering of sustainability-related industries in Brazil. João Carlos Ferraz, Luma Ramos, Bruno Plattek.

IIPP WP 2021/03 Deciding how to decide: Risk-opportunity analysis as a generalisation of cost-benefit analysis. Michael Grubb, Matthew Ives, Florian Knobloch, Jean-Francois Mercure, Femke J. M. M. Nijsse, Hector Pollitt, Simon Sharpe, Jorge Vinuales.

IIPP WP 2021/04 New economics of assistive technologies: A call for a missions approach. Sarah Albala, Catherine Holloway, Victoria Austin, Rainer Kattel.

IIPP WP 2021/05 Why ethics of quantification is needed now. Andrea Saltelli, Antonio Andreoni, Wolfgang Drechsler, Jayati Ghosh, Rainer Kattel, Ingrid H. Kvangraven, Ismael Rafols, Erik S. Reinert, Andy Stirling, Ting Xu.

IIPP WP 2021/06 A dynamic theory of public banks (and why it matters). Thomas Marois.

IIPP WP 2021/07 Altered States: Cartesian and Ricardian dreams. Erik S. Reinert, Monica di Fiore, Andrea Saltelli, Jerome R. Ravetz.

IIPP WP 2021/08 Lessons from the past 21st century systems of state-owned enterprises: The case of Italy's IRI in the 1930s. Simone Gasperin.

IIPP WP 2021/09 Building state capacities and dynamic capabilities to drive social and economic development: The case of South Africa. Mariana Mazzucato, Mzukisi Qobo, Rainer Kattel.

IIPP WP 2021/10 Mission-oriented policies and the "Entrepreneurial State" at work: An agent-based exploration. Giovanni Dosi, Francesco Lamperti, Mariana Mazzucato, Mauro Napoletano, Andrea Roventini.

IIPP WP 2021/11 Heterogenous investors, scale economies & the commercialisation of innovative renewable energy. Gregor Semieniuk, José Alejandro Coronado, Mariana Mazzucato.

IIPP WP 2022/01 Governing finance to support the net-zero transition: lessons from successful industrialisation. Olga Mikheeva, Josh Ryan-Collins.

IIPP WP 2022/02 A new data deal: the case of Barcelona. Fernando Monge, Sarah Barns, Rainer Kattel, Francesca Bria.

IIPP WP 2022/03 How can South Africa advance a new energy paradigm? A mission-oriented approach to megaprojects. Antonio Andreoni, Kenneth Creamer, Mariana Mazzucato, Grové Steyn.

IIPP WP 2022/04 Policy capacities for transformative innovation policy: A case study of UK Research Innovation. Julie McLaren, Rainer Kattel.

All Working Papers are available to download at the Institute for Innovation and Public Purpose website: ucl.ac.uk/iipp

ucl.ac.uk/iipp

@IIPP_UCL

UCL Institute for Innovation and Public Purpose
Gower Street, London, WC1E 6BT

General enquiries:
iipp-research@ucl.ac.uk
Tel: +44 (0)20 3108 6961