IMPACT RESEARCH SERIES #1

Biodiversity

The Impact Research Series (IRS) is the new biannual publication from MRC. Each edition will synthesize research on a specific topic to which MRC has contributed, through financial support or active co-research. This series aims to highlight key areas for practitioners in sustainable finance, providing insights that can guide decision-making and best practices.

Publications on biodiversity by MRC partners

This first Impact Research Series summarizes research conducted on the topic of biodiversity across various initiatives supported by MRC. Three papers are summarized throughout the document. The first paper discusses biodiversity finance in the specific context of blended finance and was produced as part of MRC's collaboration with Columbia's Sustainable Investing Research Initiative (SIRI) at Columbia University's School of International and Public Affairs (SIPA). The second paper explores how biodiversity risks can affect asset prices and was created as part of MRC's collaboration with the Impact Investing Chair at the National School of Statistics and Economic Administration of Paris (ENSAE Paris), building on research conducted at the Center for Research in Economics and Statistics (CREST). Finally, this IRS #1 summarizes the research conducted by the Fondation pour la Recherche sur la Biodiversité (FRB) on biodiversity risk assessment and mitigation methods for wind turbines.

The series concludes with a discussion of how investment teams leverage research and academic insights from Mirova's Research Center to enhance their decision-making capabilities.

Summary of Biodiversity Finance, Flammer, Giroux, Heal (2024), an initiative of Columbia's SIRI

Introduction

➜ Read the full paper here.

Biodiversity finance involves investments in biodiversity that generate financial returns by monetizing ecosystem services such as carbon credits, ecotourism and sustainable agriculture. Such investments may come in the form of direct private investments or blended finance (which combines private and public or philanthropic capital to mitigate risk and improve returns). This paper presents a conceptual framework for biodiversity finance and an empirical analysis of biodiversity investment deals, identifying a three-dimensional efficient frontier comprising return, risk, and biodiversity impact.

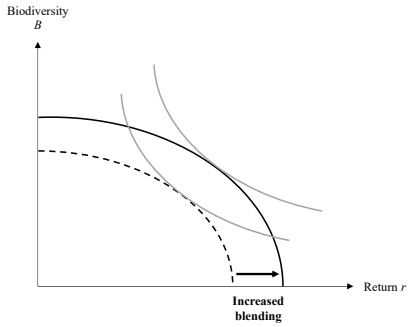
Conceptual Framework

While pure capital is favored when expected financial returns are high, blended finance makes riskier (and more impactful) investments viable by leveraging public or philanthropic funding to mitigate risk and subsidize concessional returns for private funds. In technical terms, blended capital shifts the efficient frontier (Figure 1).

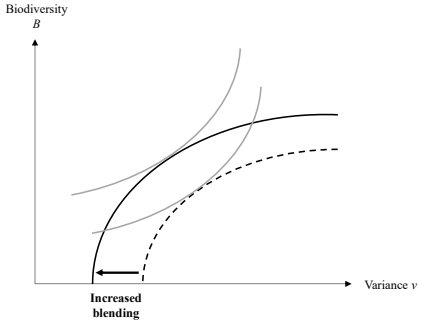
Figure 1: Blending and efficient frontier

Figure 2. Blending and efficient frontier

A. Efficient frontier in the $(B - r)$ plane



B. Efficient frontier in the $(B - v)$ plane



Notes. This figure illustrates how an increase in blending (represented by the shift from the dashed to the solid curve) affects the efficient frontier in the model of Section 2.3. Panel A refers to the biodiversity-financial return $(B - r)$ plane (holding the variance v constant), while Panel B refers to the biodiversity-variance $(B - v)$ plane (holding the return r constant). The gray lines represent the investors' indifference curves.

To formalize this relationship, this paper uses a mean-variance model, where investors' utility function depends on expected return *r*, variance *v*, and biodiversity impact *B*:

$$1 \quad U(r,v,B) \text{ such that } \frac{\partial U}{\partial r} > 0, \quad \frac{\partial U}{\partial v} < 0, \quad \frac{\partial U}{\partial B} > 0$$

Where the positive partial derivatives with respect to return r and biodiversity impact B indicate that investors are better-off with higher returns and conservation success, while the negative partial derivative with respect to *v* reflects investors' risk aversion.

The framework also considers Knightian uncertainty (ambiguity), wherein lack of familiarity with biodiversity finance requires fact-finding investments funded by concessionary capital.

Methodology

The authors carried out their empirical analysis using a proprietary dataset from a Biodiversity Investment Manager (BIM), which covers 33 biodiversity finance deals completed between 2020 and 2022. For each deal, they collect key variables including:

- ***Financial indicators:*** expected internal rate of return (IRR), financial risk (measured as deviation from expected IRR), investment structure (equity, debt, or voluntary emission reduction purchase agreements (VERPA)).
- ***Biodiversity impact metrics:*** hectares of protected/restored land, estimated carbon sequestration (in tCO_2e), number of beneficiaries and jobs created.
- ***Financing structure:*** whether the deal is pure private capital or blended finance.

It delves into the trade-offs between financial returns and biodiversity impact by comparing projects financed by pure private capital and those using blended finance.

Conclusions

Empirical findings

1. *Pure private capital projects have a higher return but are also riskier.* Pure private capital projects have an average expected IRR of 14.7%, compared to 11.9% for blended finance deals. The latter exhibit lower risk, however, with a standard deviation of IRR at 6.3%, versus 6.7% for private capital deals.
2. *Blended finance projects have significantly greater environmental benefits.* Biodiversity impact metrics reveal such projects cover a larger impact area (114,798 vs. 26,844 hectares for pure capital projects), reduce more CO_2 emissions (9.5 million vs. 2.6 million tons of CO_2 equivalent), and benefit more people (19,133 vs. 5,185 individuals).
3. *Blended finance deals are larger in scale* ($29.2M vs. $18.2M) and rely more on debt financing (47% vs. 26%).
4. *Blending shifts the efficient frontier* (as predicted by the theoretical model). Figure 1 illustrates how the efficient frontier expands as blending increases (improving return and reducing variance for a given level of biodiversity impact).

Practical implications

Private capital alone is unlikely to address biodiversity challenges but can effectively be mobilized through blended finance structures. The authors suggest public policies could:

1. *Expand the availability of concessionary capital to support blended finance models.*
2. *Standardize biodiversity impact metrics* (to enhance transparency and thus attract investors).
3. *Improve the monetization of conservation efforts* by encouraging financial innovations (such as biodiversity credits).

De-risking mechanisms can make high-impact projects financially viable. While private capital is crucial to bridge the biodiversity funding gap, effective public policies and concessionary capital are paramount to enhancing investment attractiveness and scaling biodiversity finance initiatives.

Summary of The Biodiversity Premium, Coqueret, Giroux and Zerbib (2024), an initiative of ENSAE Paris

Introduction

➜ Read the full paper here.

Leveraging an empirical asset pricing framework, the authors analyze how biodiversity risks affect asset prices. They construct biodiversity risk factors based on corporate biodiversity impact and evaluate their performance relative to established financial factors. It appears biodiversity risk has been increasingly priced since 2021, with low-biodiversity footprint firms benefiting from a risk premium.

Data and Methodology

The authors leverage Iceberg Datalab's corporate footprint (CBF) data, covering 522 US firms from 2012 to 2022 and accounting for land use, greenhouse gases (GHG) emissions, air pollution, and water pollution. This data allows them to classify firms into a long-short portfolio, where the "green-minus-brown" biodiversity factor is long when the corresponding firm has a low biodiversity intensity, and short when it has a high intensity.

They then assess risk pricing using a two-pass Fama-MacBeth (1973) regression. In the first pass, rolling betas of stock returns on biodiversity factors are estimated; rolling betas are time-varying coefficients that measure a stock's changing sensitivity to a factor (here, biodiversity) over a moving time window. This approach sheds light on the evolving relationship between stock returns and biodiversity risk exposure. In the second pass, these betas are regressed on realized and expected returns to estimate risk premia.

Expected returns are modeled by the authors as a function of biodiversity risk:

$$\lambda_{i,t} = \varphi_1 + \varphi_2 \lambda_{i,t-1} + \varphi'_3 X_{t-1} + \varepsilon_{i,t} \quad (2)$$

Where:

- $\lambda_{i,t}$ is the rolling one-year biodiversity risk price (i.e., how much investors demand to be compensated for exposure to biodiversity risk) for biodiversity factor *i* at time *t*.
- φ_1 is constant and represents the baseline level of the biodiversity risk premium.
- $\varphi_2 \lambda_{i,t-1}$ measures persistence – how much past biodiversity risk pricing affects the current risk pricing.
- $\varphi'_3 X_{t-1}$ collects explanatory variables influencing biodiversity risk pricing (biodiversity attention index, climate risk index, oil prices, consumer sentiment index, risk aversion index).
- $\varepsilon_{i,t}$ is the error term.

Conclusions

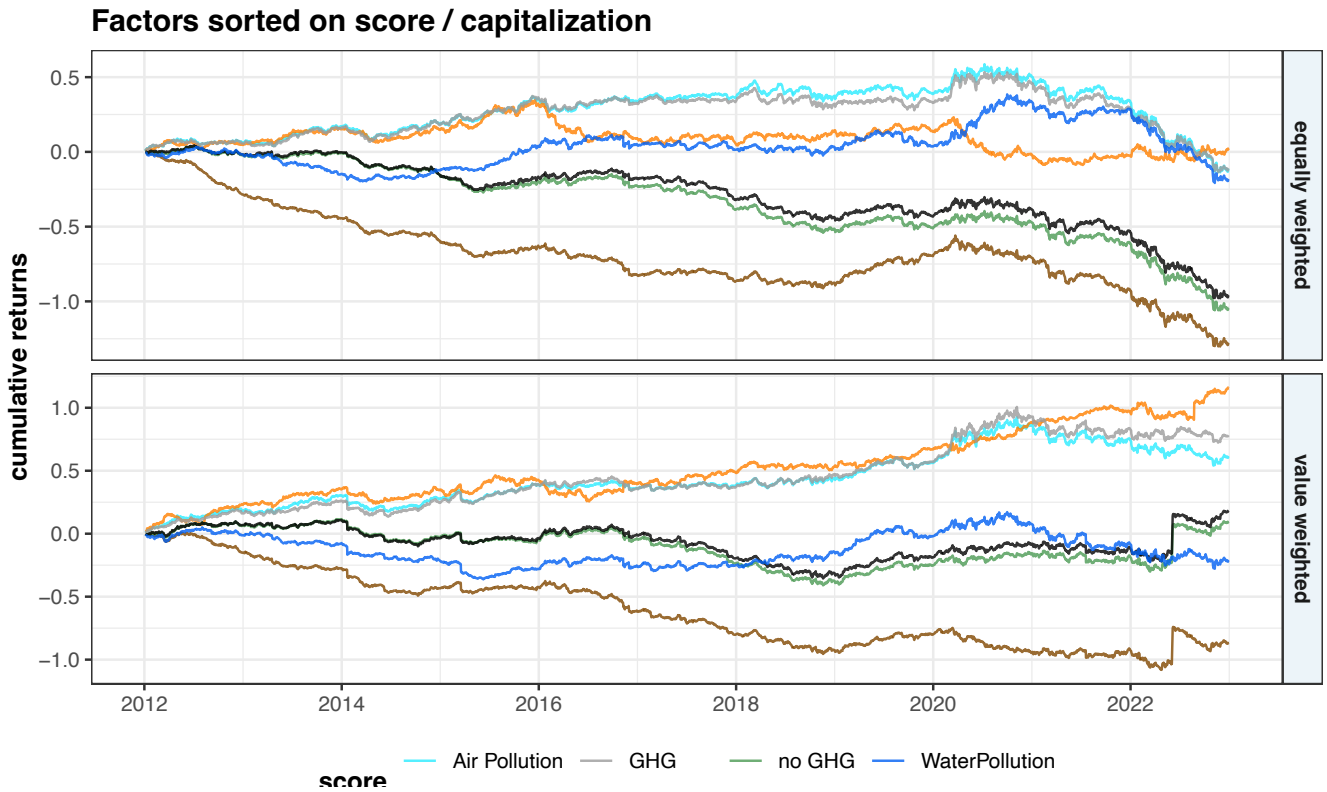
Empirical findings

Regarding model ❷, φ_2 is positive and significant, indicating investors continually adjust their risk perception. Also, biodiversity attention (contained in X_{t-1}) raises the cost of capital for high-footprint firms.

Effects are significantly heterogenous across environmental pressures. For instance, firms with high land use intensity (depicted by the brown curve on Figure 2) tend to have underperforming returns, whereas those with high CO_2 emissions (represented by the orange curve on Figure 2) show stronger returns.

Based on the entire sample, biodiversity risk premia are not statistically significant (i.e., biodiversity risk is not consistently priced across all firms). However, significant effects emerge when focusing on industries most exposed to biodiversity risks (agriculture, forestry…). In such industries, a realized return premium of 7.2% is earned by firms with lower biodiversity intensity, while their counterparts with higher intensity face a negative expected return premium of -1.5%. This indicates that investors demand higher returns in compensation for a high biodiversity footprint that exposes the firm and its stakeholders to regulatory, operational and reputational risks.

Figure 2: Cumulative returns of the green-minus-brown biodiversity factors



Practical implications

The authors suggest that:

1. Regulators should mandate *biodiversity footprint reporting*.
2. Asset managers should incorporate *biodiversity factor into their risk models and investment strategies* more generally.
3. *Tax benefits or blended finance* mechanisms could *incentivize* biodiversity-virtuous investments.

Biodiversity risks have been increasingly priced since 2021 and have significant effects in industries most prone to biodiversity risk (though not in all sectors). Namely, the growing negative premium on expected returns for high biodiversity footprint firms signals shifting investor preferences.

Reports on the biodiversity risk assessment and mitigation methods of offshore and onshore wind turbines.

Mirova Research Center has partnered with the FRB to establish a research program on the "Impact of Renewable Energies on Biodiversity." This funding program for research projects aims to better assess the impact of renewable energies on biodiversity and to produce operational recommendations for best practices aimed at stakeholders in the sector. By combining their expertise, the FRB and the Mirova Research Center are committed to promoting solutions that support both the development of renewable energies and the preservation of biodiversity.

➜ Read the full paper here.

This partnership has led to the publication, in 2025, of reports on the biodiversity risk assessment and mitigation methods of offshore and onshore wind turbines.

These reports confirmed that wind farms—on land and at sea—pose overlapping threats to wildlife, including blade collisions, noise, and habitat disruption. Offshore, added risks include construction noise, night lighting, and electromagnetic fields (EMF) from subsea cables. In 158 offshore studies reviewed, 72 % reported negative effects, such as bird and marine-mammal collisions or avoidance, while only 13 % found benefits. Onshore, bats and birds are especially vulnerable; only one mitigation stood out: raising the cut-in speed—the minimum wind speed at which turbines start spinning—to keep blades still in low winds, cutting bat deaths by nearly 67 %. Some offshore turbines also act as artificial reefs, enhancing fish and invertebrate numbers in no-fishing zones. Technologies like sensor-triggered shutdowns, ultrasonic deterrents, and black-painted blades can reduce wildlife mortality onshore by up to 90 %. But with limited data on tropical species, insects, and cumulative effects, the FRB calls for nature-inclusive designs and consistent monitoring to balance climate goals with biodiversity protection."

Academic Insights in Action: Translating Research into Investment Success

The investment teams at Mirova leverage research and academic insights from MRC to enhance their decision-making capabilities. By grounding their strategies in empirical evidence and theoretical frameworks, they can effectively identify and manage investment opportunities that align with their objectives and risk profiles. The testimony of our teams shows how valuable collaboration between academic research, our internal research teams, and our investment teams enhances not only Mirova's credibility but also its commitment to contribute.

Testimonies from our investment teams

The research conducted by the MRC plays a valuable role in shaping our investment strategies, notably by integrating biodiversity risk. It emphasizes the critical role of incorporating academic insights into our approach, especially when it comes to monetizing conservation efforts.

"As Mirova advances its biodiversity-focused strategy, the team is dedicated to identifying and investing in companies that demonstrate significant efforts to reduce pressures on biodiversity. For example, Mirova invests in firms like Tomra and SIG Group[1], which specialize in recycling technologies and sustainable packaging solutions, respectively. These companies exemplify a commitment to reducing waste and enhancing resource efficiency. Mirova is also focusing on the plant-based and organic food sectors, recognizing their potential to lessen environmental pressures associated with traditional agriculture.

Furthermore, with the aim to strengthen Mirova's impact to drive companies' transition toward more positive biodiversity impact, we are closely working with our academic partners to design a relevant framework to follow and assess shareholder engagement success and additionality."

Hervé Guez
Deputy General Manager,
Global Head of Listed Assets

1. The securities mentioned above are shown for illustrative purpose only, and should not be considered as a recommendation or a solicitation to buy or sell.

Mirova indeed finances regenerative agriculture, agroforestry, sustainable forestry and nature restoration projects, generating high-quality carbon credits. Examples include restoring a 23,000-hectare peat bog in Indonesia, which sequesters 2.5 million tonnes of CO_2 and safeguards 35 protected species[1] while creating 100 jobs and producing double-digit Internal Rate of Return (IRR)[1].

> ***Our Collaboration with the MRC helps us to stay at the forefront of developments in natural capital and conservation finance. This partnership enables the team to access the latest research and insights, creating a space for positive dialogue and knowledge sharing with all stakeholders, including project holders, institutional investors, development finance institutions and philanthropic foundations***

Anne-Laurence Roucher
Head of Private Equity and Natural Capital at Mirova

What biodiversity investments does Mirova pursue, and how do these align with the research findings?

Mirova employs a dedicated biodiversity footprint indicator that has been under development for the past three years to measure the impact of its investments on biodiversity. This indicator is designed to track pressures, reduction efforts and restoration outcomes. In collaboration with other investors, Mirova aims to make this indicator comparable and transparent, addressing the need for standardized biodiversity impact metrics, as highlighted by recent studies. This effort reflects a commitment to synthesizing a complex and multifaceted reality into a coherent framework that can be widely understood and utilized.

To monitor and report the impact of our investments effectively, Mirova relies on established academic frameworks and methodologies for measuring biodiversity and carbon credits. Leveraging such rigorous academic standards enhances the credibility of our assessments, allowing us to provide transparent and reliable evaluations of their projects' outcomes. Ultimately, Mirova's approach underscores its dedication to accountability in conservation finance and its commitment to making a meaningful impact on biodiversity.

Upcoming publications

MRC is supporting further research with these partners to address the barriers preventing blended finance from deploying at scale and to better assess shareholder engagement success on companies' real-world environmental and social impact. MRC is also extending its partnership on other topics such as social impact measurement, just transition, transition plan assessments and AI for sustainability among others. These works will be the subject of future communication in this MRC Impact Research Series.

1. Past performances do not anticipate the future performances.

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ABOUT MIROVA

Mirova is a global asset management company dedicated to sustainable investing and an affiliate of Natixis Investment Managers. At the forefront of sustainable finance for over a decade, Mirova has been developing innovative investment solutions across all asset classes, aiming to combine long term value creation with positive environmental and social impact. Headquartered in Paris, Mirova offers a broad range of equity, fixed income, multi-asset, energy transition infrastructure, natural capital and private equity solutions designed for institutional investors, distribution platforms and retail investors in Europe, North America, and Asia-Pacific. Mirova and its affiliates had €32 billion in assets under management as of March 31, 2025. Mirova is a mission-driven company*, labeled B Corp**.

ABOUT MIROVA RESEARCH CENTER

The Mirova Research Center (MRC) is the research center of excellence initiated by Mirova, a global asset management company dedicated to sustainable investing, in order to contribute to academic research on responsible finance. MRC aims to financially support long-term research projects, facilitate exchanges between the academic world and the financial industry, and propose innovative investment solutions. MRC's objective is to fund research on particularly innovative topics with a strong societal impact that are not sufficiently addressed in existing academic literature through three main axes: finance and planetary boundaries, impact indicators for a just transition, and the contribution of investors to sustainable development goals.

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