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What is the relationship between biodiversity and the frequency of financial crises? Global evidence

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ABSTRACT

The paper studies the relationship between the state of world's biodiversity proxied by the Living Planet Index and the frequency of financial crises, conditional on global economic growth and the total number of biodiversity-related environmental policy instruments, during 1970–2018. We find that the increased frequency of banking crises as well as triple crises, i.e. simultaneously occurring banking, sovereign debt and currency crises, has a detrimental effect on biodiversity. Moreover, this relationship appears bi-directional. Thus, our findings call for a joint implementation of environmental and macroprudential policies to better align the goals of biodiversity conservation and financial stability worldwide.

1. Introduction

Biodiversity has now been studied from an interdisciplinary perspective, increasingly catching the attention of scholars in social sciences, including economics and finance, e.g. Dasgupta (2021). Against this backdrop, the biodiversity-finance nexus represents an important, yet burgeoning research program with multiple gaps. They are identified in the recent conceptual works and reviews (Flammer et al., 2025; Karolyi and Tobin-de la Puente, 2023; Hutchison and Lucey, 2024) and are to be filled in by the research community.

One of the key strands of research on the biodiversity-finance nexus deals with biodiversity-related financial risks, as biodiversity loss creates physical and transition risks for financial institutions (Hudson, 2024). In particular, several recent studies document that biodiversity loss adversely affects credit portfolios and equity holdings of financial institutions, e.g. Calice et al. (2023), Hadji-Lazaro et al. (2024), Mundaca and Heintze (2024). Furthermore, Giglio et al. (2023), Liang et al. (2024) and Bassen et al. (2024) show that biodiversity-related risks can potentially entail stock price crashes.

Although biodiversity-related financial risks represent a serious concern for central banks, e.g. Kedward et al. (2023), little is known about the relationship between biodiversity and financial stability, once financial risks have materialized, i.e. in terms of financial crises. Does the frequency of financial crises affect biodiversity? Is this relationship unidirectional, running from the frequency of crises to biodiversity or vice versa? Which types of financial crises are more related to biodiversity? These questions naturally extend the studies focused on the link between financial crises and various manifestations of environmental degradation. For example, Pacca et al. (2020) investigate the impact of financial crises on air-pollutant emissions, while Antonarakis et al. (2022) explore their effect on deforestation. In the spirit of these works, the above questions build on the premise that there can be a deterioration in biodiversity, since environmental protection is weakened due to a financial crisis. This detrimental effect may be exacerbated in case different types of financial crises overlap.

To our knowledge, this paper is the first to explore the link between financial crises and biodiversity on the global level. We carry out the analysis for the period 1970–2018, using the Living Planet Index as a proxy of the state of world's biodiversity and considering the annual frequency of banking, sovereign debt, currency crises as well as their combinations, i.e. twin crises and triplets. We also account for the role of conditioning variables, i.e. world real GDP per capita growth and the total number of environmental policy instruments applied worldwide, specifically aimed at safeguarding biodiversity.

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Table 1
Descriptive statistics.

	Mean	Maximum	Minimum	Std. Dev.	Observations
GDP	1.7	4.3	−2.6	1.4	49
LPI	0.6	1.0	0.3	0.2	49
NEPI	213.1	470.0	26.0	157.0	49
BANK	3.1	22.0	0.0	4.4	49
SOVDEBT	3.7	13.0	0.0	2.8	49
CUR	7.1	25.0	0.0	5.4	49
TWIN	1.5	7.0	0.0	1.7	49
TRIPLE	0.4	3.0	0.0	0.7	49

2. Data

We adopt the Living Planet Index (*LPI*) as a measure of the state of world's biodiversity. This indicator captures population trends of vertebrate species from terrestrial, freshwater and marine habitats. It currently encompasses 31,821 populations of 5230 species. The *LPI* can be retrieved from https://www.livingplanetindex.org/latest_results and is available on the annual basis for the period 1970–2020,[1] exhibiting a persistent downward trend over this span.

Regarding the frequency of financial crises, we exploit the dataset on banking (*BANK*), sovereign debt (*SOVDEBT*), currency (*CUR*) as well as complex crises - twin (banking and currency episodes, *TWIN*) and triple crises (*TRIPLE*), provided by Nguyen et al. (2022). They updated and extended the well-established financial crisis database by Laeven and Valencia (2020).

We also include world real GDP per capita growth (*GDP*) and the total number of environmental policy instruments (*NEPI*) applied worldwide, covering various taxes and fees as well as permits and subsidies specifically aimed at safeguarding biodiversity. Both indicators are alleged to co-vary with biodiversity, while global economic growth should also relate to the frequency of financial crises. Thus, *GDP* and *NEPI* are likely to mediate the relationship between *LPI* and the frequency of financial crises. *GDP* comes from the World Development Indicators, while *NEPI* is based on the OECD Policy Instruments for the Environment (PINE) database.

Given the length of the time series for *LPI* and the data on financial crises, our empirical analysis is confined to the period between 1970 and 2018. Descriptive statistics of all variables are represented in Table 1.

3. Methodology

We employ local projections (LPs) proposed by Jordá (2005). It is an alternative method to derive impulse responses, which in certain respects appears superior to conventional vector autoregressions (VAR). LPs allow to obtain impulse responses by estimating forecasts at each period of interest rather than extrapolating at distant horizons as it is performed in VARs. Besides, LPs appears a more flexible method, since it does not build on any preliminary specification of a multivariate dynamic system to derive impulse responses. LPs are robust to misspecification, non-linearities and short time series. Another advantage of this method is that lag-augmented LPs are asymptotically valid over both stationary and non-stationary data (Olea and Plagborg-Møller, 2021). Overall, since our time series are relatively short and bi-directional relationships among the variables cannot be ruled out, we believe LPs are to be preferred to VAR estimation.

The general set-up of the equation for LPs is represented as follows:

$$y_{i,\ t+s} = \alpha_{i,s} + D\_shock_{i,t-1}\beta_s + D\_x_{i,t-1}\gamma_s + u_{i,t+s} \quad (1)$$

where $y_{i,\ t+s}$ refers to the dependent variable; in our case, the dependent variable iteratively takes on the value of one of the indicators in the following vector: [the total number of environmental policy instruments aimed at safeguarding biodiversity (*NEPI*), the Living Planet Index (*LPI*), the frequency of financial crises (*BANK*, *SOVDEBT*, *CUR*, *TWIN and TRIPLE*) and world real GDP per capita growth (*GDP*)]; $\alpha_{i,s}$ stands for country fixed effects. $\text{D\_Shock}_{i,\ t-1}$ is one of the first-differenced variables from the above mentioned vector. The vector $D\_x_{i,t-1}$ contains the control variables which are the same as the first-differenced variables from the above vector, excluding the variable which is regarded as a shock. The impulse response $y_{i,\ t+s}$ is estimated with respect to a change in the shock and control variables over the horizon $s = 0,\ldots,12$.

For instance, in case of the relationship between the Living Planet Index and the frequency of banking crises, we essentially estimate the following set of equations:

$$\text{NEPI}_{i,\ t+s} = \gamma_{i,s} + \lambda_1 \text{D\_NEPI}_{t-1} + \lambda_2 \text{D\_LPI}_{t-1} + \lambda_3 \text{D\_BANK}_{t-1} + \lambda_4 \text{D\_GDP}_{t-1} + \mu_{i,\ t+s} \quad (2)$$

$$\text{LPI}_{i,\ t+s} = \beta_{i,s} + \mu_1 \text{D\_NEPI}_{t-1} + \mu_2 \text{D\_LPI}_{t-1} + \mu_3 \text{D\_BANK}_{t-1} + \mu_4 \text{D\_GDP}_{t-1} + \epsilon_{i,\ t+s} \quad (3)$$

$$\text{BANK}_{i,\ t+s} = \omega_{i,s} + \zeta_1 \text{D\_NEPI}_{t-1} + \zeta_2 \text{D\_LPI}_{t-1} + \zeta_3 \text{D\_BANK}_{t-1} + \zeta_4 \text{D\_GDP}_{t-1} + \varepsilon_{i,\ t+s} \quad (4)$$

$$\text{GDP}_{i,\ t+s} = \alpha_{i,s} + \eta_1 \text{D\_NEPI}_{t-1} + \eta_2 \text{D\_LPI}_{t-1} + \eta_3 \text{D\_BANK}_{t-1} + \eta_4 \text{D\_GDP}_{t-1} + \text{u}_{i,\ t+s} \quad (5)$$

In each of the equations, we treat one of the regressors iteratively as a shock whereas the other variables are controls. We resort to the Cholesky identification with the following variable ordering: total number of environmental policy instruments→Living Planet Index→frequency of banking (sovereign debt/currency/twin/triple crises)→global economic growth. We believe that such ordering properly gauges the increasing degree of variable endogeneity. Namely, the total number of environmental policy instruments appears the most exogenous variable, being largely at the discretion of policymakers, while global economic growth may have bidirectional linkages with the rest of the variables, thereby being the most endogenous. We apply OLS to estimate this set of equations.

We implement an R package for LPs developed by Adämmer (2019).[2] Based on this package, impulse response functions (IRFs) are obtained, revealing lead-lag relationships among the variables. The IRFs are reported with 95 % confidence intervals for 12 periods ahead the initial shock.

4. Results

The results are presented in Figs. 1–5 below.

Of all the crisis types, the frequency of banking crises and triplets exerts a direct detrimental effect on the Living Planet Index. Since sovereign debt and currency crises do not drive the latter directly,[3] the adverse impact of triplets on the state of world's biodiversity must also be shaped by the frequency of banking crises.

In contrast to other crisis types, the frequency of banking crises involves a statistically significant decline in world real GDP per capita

[1] Although there are other measures gauging the state of world's biodiversity, e.g. the Red List Index (https://www.iucnredlist.org) or Biodiversity Intactness Index (https://www.nhm.ac.uk/our-science/services/data/biodiversity-intactness-index.html), the *LPI* covers the longest time span without any missing values and is adopted by the Convention of Biological Diversity as an indicator of progress to measure the goals set by the UN Biodiversity Conference (COP15) held in 2022.

[2] The package is publicly available at https://cran.r-project.org/web/packages/lpirfs/lpirfs.pdf

[3] The effect of sovereign debt crises on *LPI* is roundabout: the increased frequency of such crises adversely affects *NEPI* first. Meanwhile, there is no evidence of the frequency of currency and twin crises affecting *LPI* in a direct or indirect way.

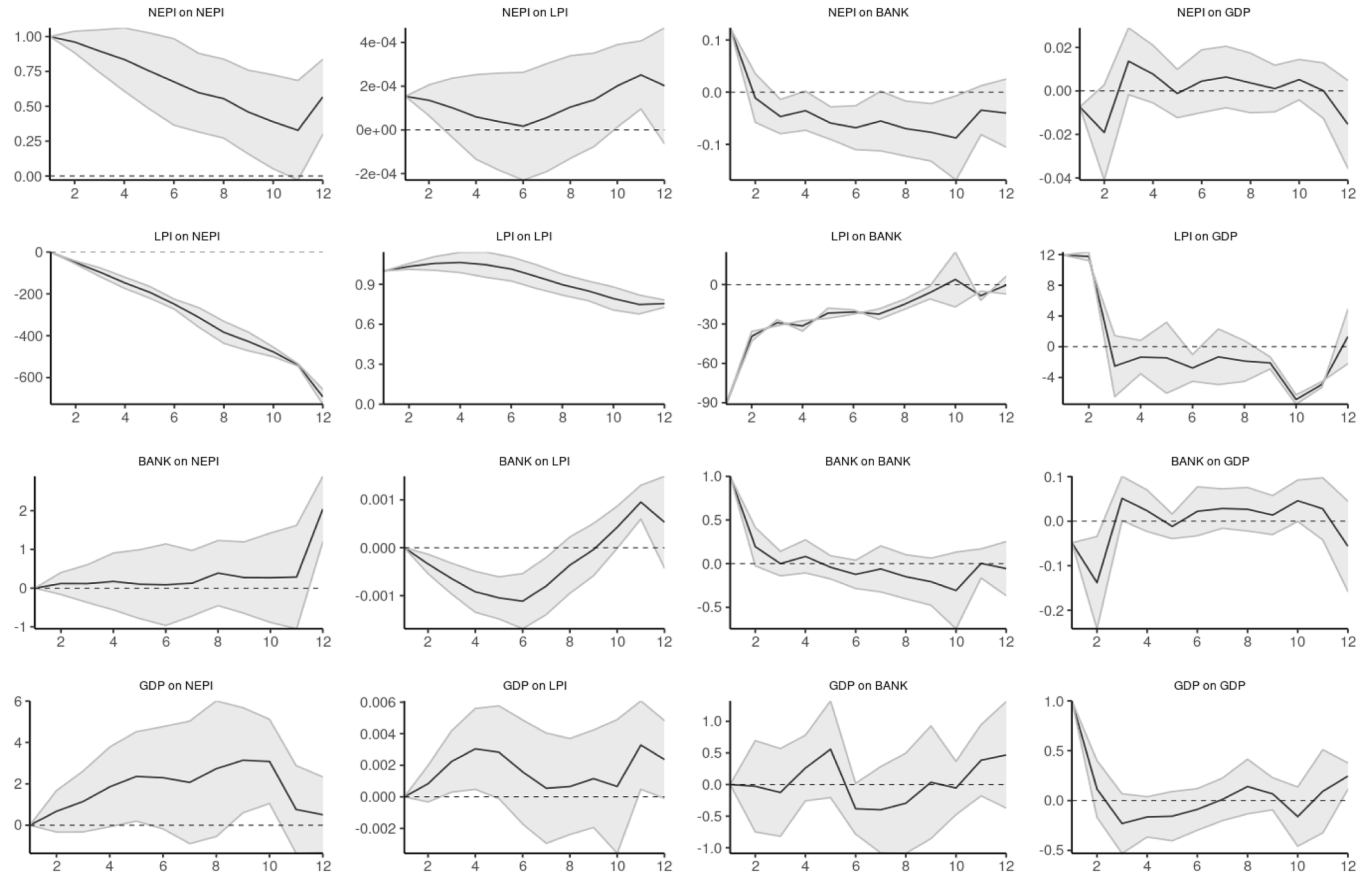

Fig. 1. IRFs for *BANK, LPI, NEPI* and *GDP*.
Note: the impulse is associated with the variable mentioned first in the pairwise graphs above, the second variable represents the response. The shaded area corresponds to the 95 % confidence bands of the impulse response function.

growth. Since the latter is positively related to the total number of environmental policy instruments aimed at safeguarding biodiversity, the increased occurrence of banking crises worldwide can entail a depletion of funding available for biodiversity conservation through the contraction of global economic growth.

Apart from causing the shortage of funding for biodiversity conservation, banking crises adversely impact innovation and technological adoption, e.g. Hardy and Sever (2021), thereby impeding the replacement of outdated equipment which can damage biodiversity even when operated by benevolent and environmentally-oriented firms. Also, banking crises lead to the expansion of the informal sector in the economy, e.g. Colombo et al. (2016). The latter extensively exploits low-productive technologies hampering biodiversity, while it is hard to impose and enforce fines and other restrictions on the informal firms due to their opacity.[4]

Our findings have a policy implication showcasing that macroprudential policy measures aimed at averting banking crises and triplets may bring about a positive externality, allowing to finance more of biodiversity-related environmental policy instruments.[5] Namely, if the macroprudential policy measures are successful in preventing a worldwide wave of banking crises, no global recession occurs. Hence, more funds can be allocated to increase the number of biodiversity-related environmental policy instruments. Similarly, firms are more likely to adopt technologies safeguarding biodiversity.

Importantly, a decline in the *LPI* in its turn undermines financial stability by increasing the frequency of all the crises except triplets. This impact should be offset by increasing *NEPI*. Hence, it is vital to align the goals of biodiversity conservation and financial stability worldwide. To this end, environmental and macroprudential policies need to be perceived as complements. The need for such complementarity is emphasized by Lee et al. (2024) and Luo (2024), albeit in the framework distinctive from ours. Namely, Luo et al. (2024) consider a sample of 11 largest economies during 1992–2020 and conclude that environmental policy strengthens the positive impact of macroprudential measures on environmental sustainability. Based on a sample of banks from 28 countries over 2004–2020, Lee et al. (2024) argue that environmental policy effectively decreases bank risk in case of ex ante tighter capital and leverage regulation.

Thus, our study appears the first to provide empirical evidence that the complementarity between environmental and macroprudential policy is also essential as regards biodiversity conservation on the global scale.

5. Conclusion

Building on local projections as an estimation method, we shed light on the relationship between the state of world's biodiversity proxied by the Living Planet Index and the frequency of financial crises during 1970–2018, also accounting for the role of global economic growth and

[4] Against this backdrop, it is no surprise that there is empirical evidence of an increasing number of biodiversity crimes committed during economic and financial crises such as illegal logging, hunting, etc. (Troumbis and Zevgolis, 2020).

[5] Delving into specific macroprudential policy instruments is beyond the scope of the study, though we conjecture that, apart from conventional macroprudential measures, green macroprudential instruments may facilitate the financing of biodiversity-related environmental policies. See, for example, D'Orazio and Popoyan (2019) for a taxonomy of green macrorudential policies.

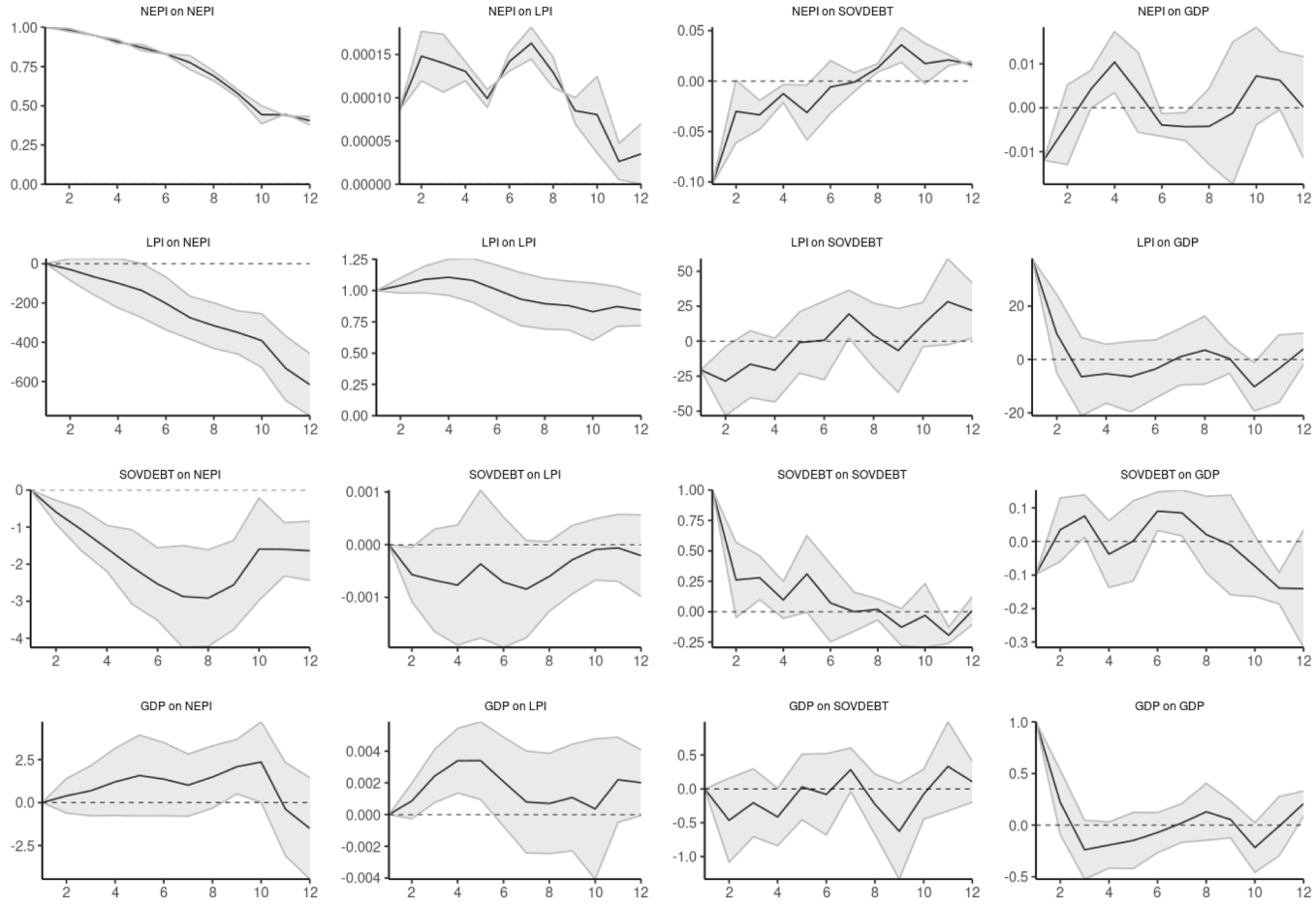

Fig. 2. IRFs for *SOVDEBT, LPI, NEPI* and *GDP*.
Note: the impulse is associated with the variable mentioned first in the pairwise graphs above, the second variable represents the response. The shaded area corresponds to the 95 % confidence bands of the impulse response function.

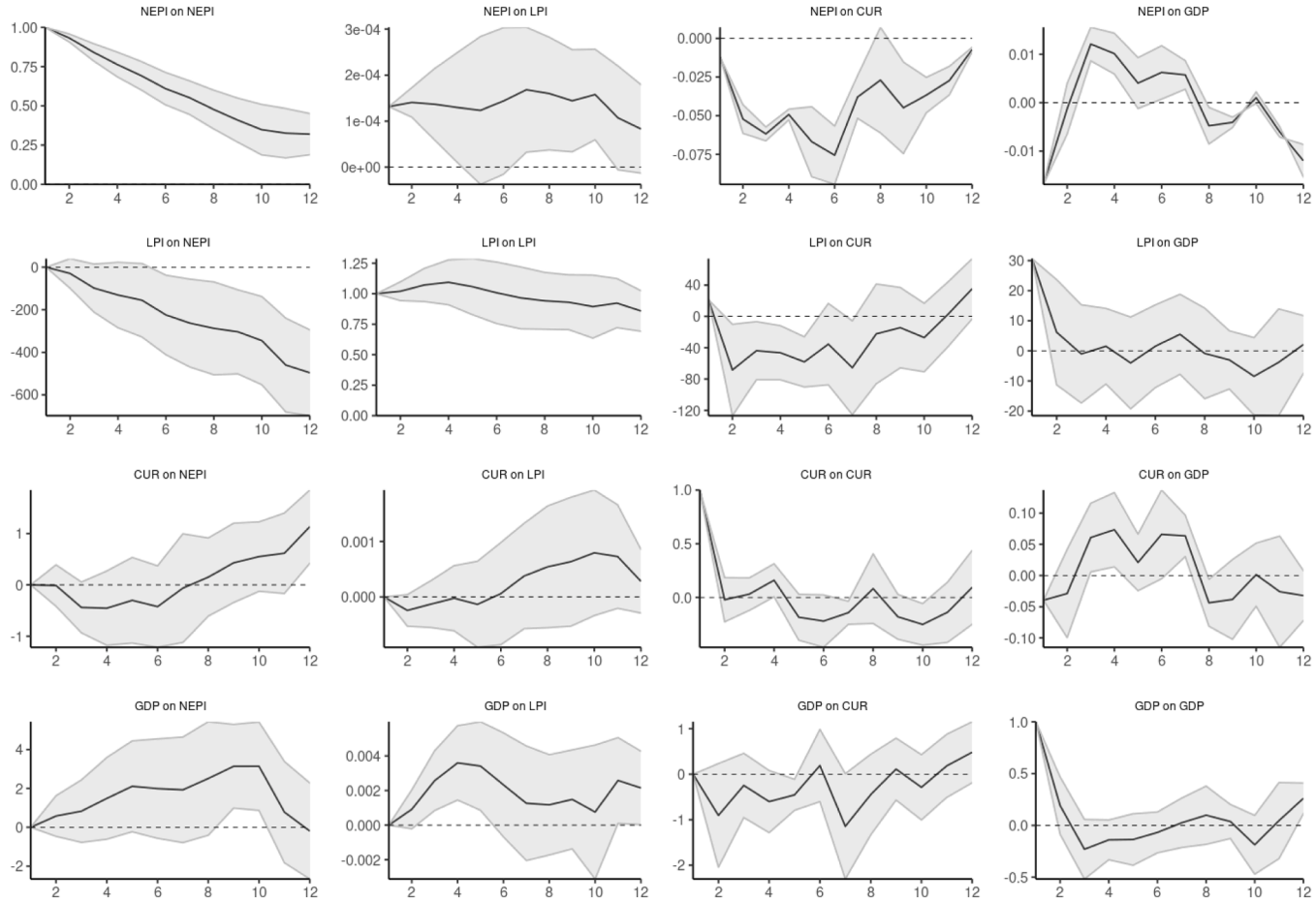

Fig. 3. IRFs for *CUR, LPI, NEPI* and *GDP*.
Note: the impulse is associated with the variable mentioned first in the pairwise graphs above, the second variable represents the response. The shaded area corresponds to the 95 % confidence bands of the impulse response function.

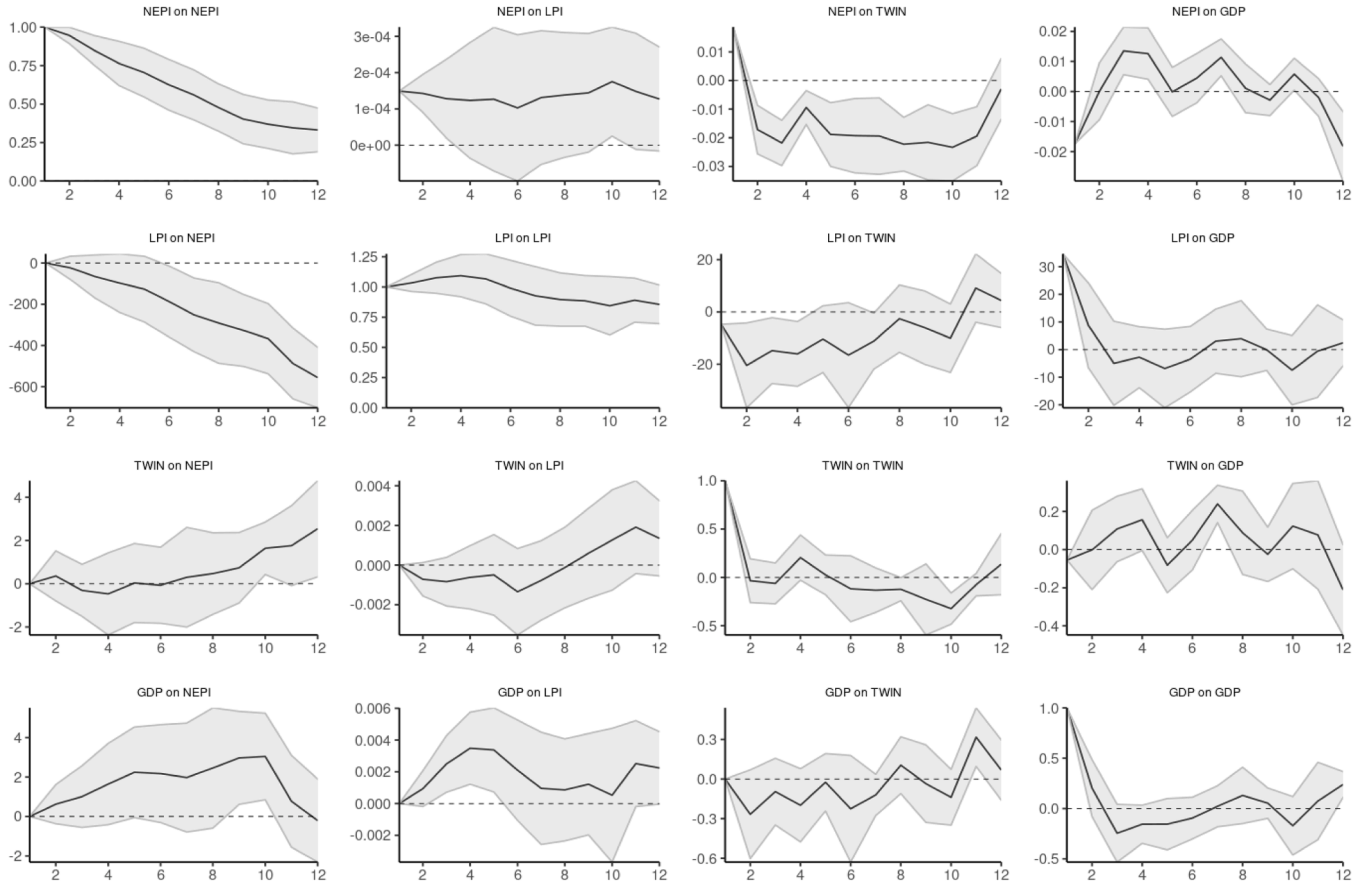

Fig. 4. IRFs for *TWIN, LPI, NEPI* and *GDP*.
Note: the impulse is associated with the variable mentioned first in the pairwise graphs above, the second variable represents the response. The shaded area corresponds to the 95 % confidence bands of the impulse response function.

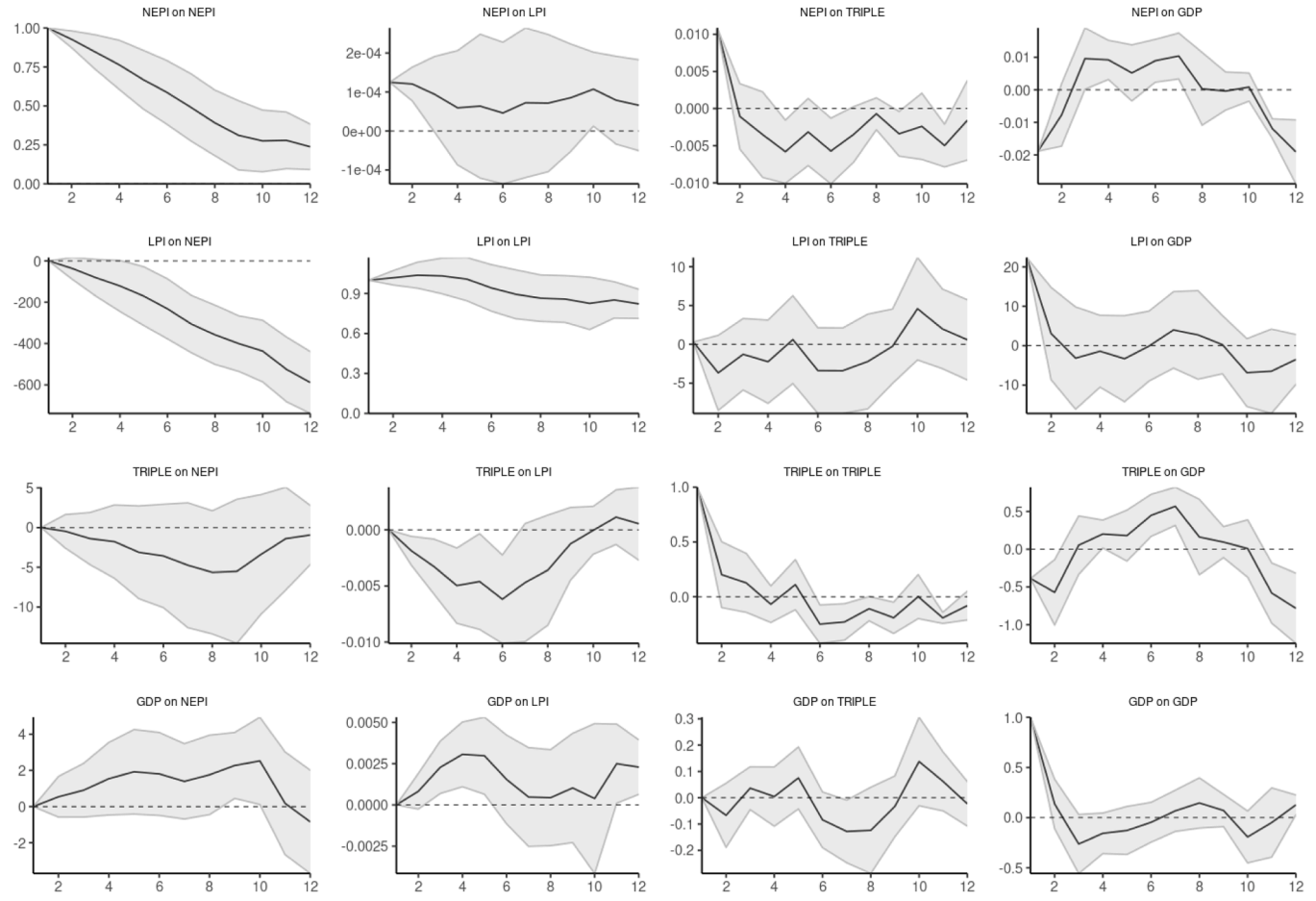

Fig. 5. IRFs for *TRIPLE, LPI, NEPI* and *GDP*.
Note: the impulse is associated with the variable mentioned first in the pairwise graphs above, the second variable represents the response. The shaded area corresponds to the 95 % confidence bands of the impulse response function.

total number of biodiversity-related environmental policy instruments applied worldwide.

We find that the frequency of banking crises and triplets appears the most hazardous for the state of world's biodiversity. The effect of sovereign debt crisis frequency is transmitted through a decrease in the total number of biodiversity-related environmental policy instruments. In case of currency and twin crises, no impact on the Living Planet Index is found. However, a deterioration in the Living Planet Index increases the frequency of all the financial crises except triplets. Thus, our findings provide evidence in favor of a joint implementation of environmental and macroprudential policies to reconcile the goals of biodiversity conservation and financial stability.

Data availability

Data will be made available on request.

References

Adämmer, P., 2019. Lpirfs: An R Package to Estimate Impulse Response Functions by Local Projections. R J. 11 (2), 421–438.

Antonarakis, A., Pacca, L., Antoniades, A., 2022. The effect of financial crises on deforestation: a global and regional panel analysis. Sustainability Sci. 17, 1037–1057.

Bassen, A., Buchholz, D., Lopatta, K., Rudolf, A.R., 2024. Biodoversity management and stock price crash risk. Business Strategy and the Environment 33 (5), 4788–4805.

Calice, P., Diaz, F., Nepomuk Dunz, K., Miguel, F., 2023. Biodiversity and finance: a preliminary assessment of physical risks for the banking sector in emerging markets. World Bank Policy Res. Working Paper 10432.

Colombo, E., Onnis, L., Tirelli, P., 2016. Shadow economies at times of banking crises: empirics and theory. J. Bank. Finance 62, 180–190.

Dasgupta, P., 2021. The economics of biodiversity: the dasgupta review. Hm Treasury.

D'Orazio, P., Popoyan, L., 2019. Fostering green investments and tackling climate-related financial risks: which role for macroprudential policy? Ecol. Econ. 160, 25–37.

Flammer, C., Giroux, T., Heal, G., 2025. Biodiversity finance. J. Financ. Econ. 164, 103987.

Giglio, S., Kuchler, T., Stroebel, J., Zeng, X., 2023. Biodiversity risk. NBER Working Paper 31137.

Hadji-Lazaro, P., Salin, M., Svartzman, R., Espagne, E., Gauthey, J., Berger, J., Calas, J., Godin, A., Vallier, A., 2024. Biodiversity loss and financial stability as a new frontier for Central banks: an exploration for France. Ecol. Econ. 223, 108246.

Hardy, B., Sever, C., 2021. Financial crises and innovation. Eur. Econ. Rev. 138, 103856.

Hudson, R., 2024. Biodiversity and risk in the financial sector. J. Sustain. Finance Account. 2, 100009.

Hutchison, M., Lucey, B., 2024. A biobliometric and systemic literature review of Biodiversity finance. Finance Res. Lett. 64, 105377.

Jordá, O., 2005. Estimation and inference of impulse responses by local projections. Am. Econ. Rev. 95 (1), 161–182.

Karolyi, A., Tobin-de la Puente, J., 2023. Biodiversity finance: a call for research into financing nature. Financ Manage 52, 231–251.

Kedward, K., Ryan-Collins, J., Chenet, H., 2023. Biodiversity loss and climate change interactions: financial stability implications for Central banks and financial supervisors. Climate Policy 23 (6), 763–781.

Laeven, L., Valencia, F., 2020. Systemic banking crises database II. IMF Economic Review 68, 307–361.

Lee, C.-C., Wang, C.-W., Hong, P.-H., Lin, W., 2024. Environmental policy stringency and bank risks: does green economy matter? Int. Rev. Financial Anal. 91, 103040.

Liang, C., Yang, J., Shen, L., Dong, D., 2024. The role of biodiversity risk in stock price crashes. Finance Res. Lett. 67(A), 105856.

Luo, H., Sun, Y., Zhang, L., 2024. Effects of macroprudential policies on ecological footprint: the moderating role of environmental policy stringency in the top 11 largest countries. Sci. Rep. 14 article number 7423.

Mundaca, L., Heintze, J.-N., 2024. Banking on ecosystem services. Ecol. Econ. 224, 108284.

Nguyen, T.C., Castro, V., Wood, J., 2022. A new comprehensive database of financial crises: identification, frequency and duration. Econ. Model. 108, 105770.
Olea, J., Plagborg-Møller, M., 2021. Local projection inference is simpler and more robust than you think. Econometrica 89 (4), 1789–1823.
Pacca, L., Antonarakis, A., Schröder, P., Antoniades, A., 2020. The effect of financial crises on air pollutant emissions: an assessment of the short vs. Medium-term effects. Sci. Total Environ. 698, 133614.
Troumbis, A., Zevgolis, Y., 2020. Biodiversity crime and economic crisis: hidden mechanisms of misuse of ecosystem goods in Greece. Land Use Policy 99, 105061.