Chinese corporate biodiversity exposure

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ABSTRACT

We present time series indices of corporate biodiversity risk exposure for listed Chinese companies. Utilizing recent advancements in text-as-data techniques, we analyze the annual reports of more than 4000 companies spanning a 15-year period. Our study introduces two indices: an exposure index, inspired by the work of Giglio et al., 2023, and an extensiveness index, which draws from policy uncertainty indices like Lucey et al. (2022). Our findings reveal substantial exposure to biodiversity risks among Chinese companies, notably exceeding levels observed in the USA. Corporate-level data are available as an Internet appendix to this note.

1. Introduction

Earth is facing a biodiversity crisis. The World Wildlife Fund Living Planet index[1] has declined by over 50% in four decades. At its extreme, a lifeless ecosphere would render all business activity impossible. Thus, there is a compelling business imperative to maintain ecological health. Recent work, such as Dasgupta (2024) or Giglio et al. (2024) has highlighted and surfaced the channels by which biodiversity can impact on corporates financial side. A substantial body of work has long aimed to capture the extent and importance of "natural capital"—the ecological foundations of business such as water and forests. The intersection of finance and natural capital involves evaluating and integrating the value of ecosystems and biodiversity into financial decision-making. These complex tasks have given rise to a large body of literature, particularly in natural capital accounting. While a well-developed literature exists at the macro level (See Wackernagel et al., 1999; Costanza et al., 2014 for examples), firm-level measures have been scarce until recently. This contrasts sharply with carbon/climate issues, where various firm-level indices and measures have emerged. Zhu et al. (2024) highlighted the need for improved corporate biodiversity measures. However, the vast majority of corporate-level biodiversity measures focus on internal monitoring and assessment (Lammerant et al., 2021).

Nevertheless, research on biodiversity/conservation and firm effects has begun to emerge. Enhanced biodiversity conservation has been linked to improved reputation (Bassen et al., 2024), financial performance (White et al., 2023), stock returns, and corporate value (Smith et al., 2020). It also significantly reduces the likelihood of future stock crashes (Xin et al., 2023; Bassen et al., 2024). Limited evidence suggests that investors care about corporate biodiversity (Garel et al., 2024), and portfolios formed based on biodiversity exposure may serve as an equity hedge (Giglio et al., 2023). What is missing as of yet however is a well accepted theoretical model of how exactly exposure to various degrees of biodiversity risk impacts on corporate decisions. To some extent that has been down to the lack of exposure date - without stylized facts theorizing is hampered. Giglio et al. (2024) makes perhaps a first attempt at this. Similar to the approach in Dasgupta (2024) they combine insights from environmental economics

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[1] The Living Planet Index (LPI) measures the state of the world's biological diversity based on population trends of vertebrate species from terrestrial, freshwater and marine habitats,. Data here: https://www.livingplanetindex.org/
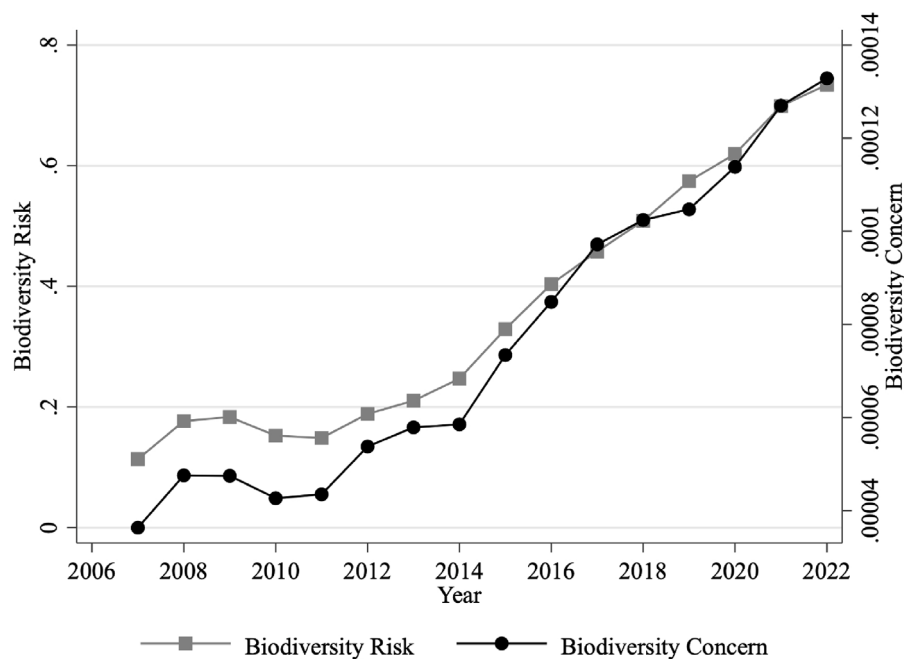
Fig. 1. Biodiversity Indices over time.

(around aggregate production functions and spillovers) and natural capital research to attempt to model how biodiversity enters the production function. It is important to note however that this remains at a high level of abstraction.

The corporate-level data sources for these papers have primarily been one of three measures: proprietary data from Iceberg Data Lab, components of the E (part of ESG) measure from Bloomberg, or data from Giglio et al. (2023). The latter, in particular, has gained widespread use, being freely available at https://www.biodiversityrisk.org/download/. While useful, this dataset is limited to the USA only. This paper is structured as follows: Section 1 introduces the study, setting the context and objectives. Section 2 describes the data sources and selection criteria used for analysis. Section 3 explains the methodology. Section 4 presents the empirical findings, highlighting key trends and patterns observed. Finally, Section 5 concludes with a discussion of the results and provides recommendations for future research directions.

2. Data

The data are sourced from the annual reports of publicly listed Chinese companies, covering the period from 2007 to 2022. In total, the dataset includes 43,231 firm-year observations from 4,708 companies. The primary reason for using annual report texts is that the language used in these reports largely reflects a firm's strategic characteristics and development direction. As companies play a crucial role in biodiversity conservation and are key drivers of biodiversity protection, the attention given to biodiversity in annual reports indicates a firm's commitment to sustainable development and environmental responsibility. This approach is consistent with the existing research which uses US corporate 10k reports.

3. Methodology

We employ a text analysis approach to measure the degree of corporate attention to biodiversity. First, we reference the biodiversity dictionary constructed by Giglio et al. (2023), which includes the following biodiversity-related terms: biodiversity, ecosystem(s), ecology/ecological, habitat(s), species, (rain)forest(s), deforestation, fauna, flora, marine, tropical, freshwater, wetland, wildlife, coral, aquatic, desertification, carbon sink(s), ecosphere, and biosphere. Second, we conducted text mining within the annual reports published by listed companies in China, tallying the frequency of these biodiversity terms. Finally, We then created the *Biodiversity Risk* Index by assigning a value of 1 if the term frequency exceeded two occurrences, and 0 otherwise. Finally, we calculated the character count of these terms and derived the *Biodiversity Concern* Index by taking the ratio of the biodiversity keyword character count to the total character count of the annual report. Through these two approaches, we established biodiversity indices at the firm-year level. A downloadable Excel copy of the data is available here, usable on condition of citation.
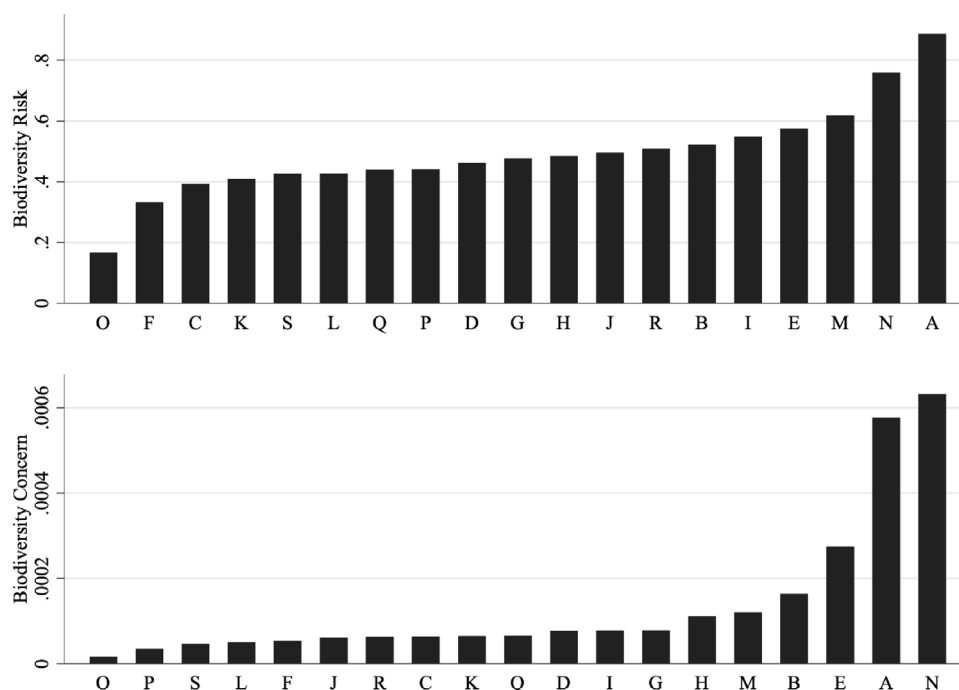
Fig. 2. Biodiversity Indices by industry.

Table 1

Biodiversity Indices by industry.

Code	Name	Firm Num	Biodiversity Risk		Biodiversity Concern	
			Mean	SD	Mean	SD
A	Agriculture, forestry, animal husbandry, fishery	41	0.8866	0.3174	0.0005771	0.0010883
B	Mining	76	0.5220	0.4998	0.0001637	0.0005067
C	Manufacturing	3134	0.3934	0.4885	0.0000640	0.0002217
D	Electricity, heat, gas and water production and supply	126	0.4620	0.4987	0.0000770	0.0001634
E	Construction	93	0.5743	0.4947	0.0002747	0.0007350
F	Wholesale and retail trade	175	0.3328	0.4713	0.0000534	0.0001917
G	Transportation, warehousing and postal services	107	0.4765	0.4996	0.0000778	0.0002359
H	Accommodation and catering	8	0.4851	0.5023	0.0001114	0.0001802
I	Information transmission, software and information technology services	382	0.5493	0.4976	0.0000776	0.0001024
J	Finance	123	0.4953	0.5002	0.0000611	0.0001086
K	Real estate	96	0.4092	0.4919	0.0000645	0.0001074
L	Leasing and business services	60	0.4264	0.4949	0.0000504	0.0000763
M	Scientific research and technical services	103	0.6185	0.4862	0.0001200	0.0002288
N	Water conservancy, environment and public facilities management	89	0.7585	0.4283	0.0006320	0.0014883
O	Residential services, repairs and other services	1	0.1667	0.4082	0.0000164	0.0000206
P	Education	9	0.4423	0.4991	0.0000344	0.0000404
Q	Health and social work	15	0.4403	0.4980	0.0000650	0.0001309
R	Cultural, sports and entertainment	59	0.5083	0.5003	0.0000631	0.0000859
S	General	11	0.4261	0.4959	0.0000464	0.0000600

4. Empirical results

4.1. Data description

Fig. 1 depicts the trend in average biodiversity indices from 2007 to 2022. The indices generally show an upward trajectory, indicating an increasing frequency of biodiversity-related terms in corporate annual reports. This suggests growing attention to biodiversity as companies reflect on past performance and future prospects. The index exhibits a relatively gentle upward trend before 2012, followed by a more pronounced ascent. The most significant increase in both the Biodiversity Risk Index and the Biodiversity Concern Index occurred in 2015. This surge likely corresponds to the release of China's National Action Plan for the United Nations Decade on Biodiversity in 2012 and the announcement of the Priority Area for Biodiversity Conservation in
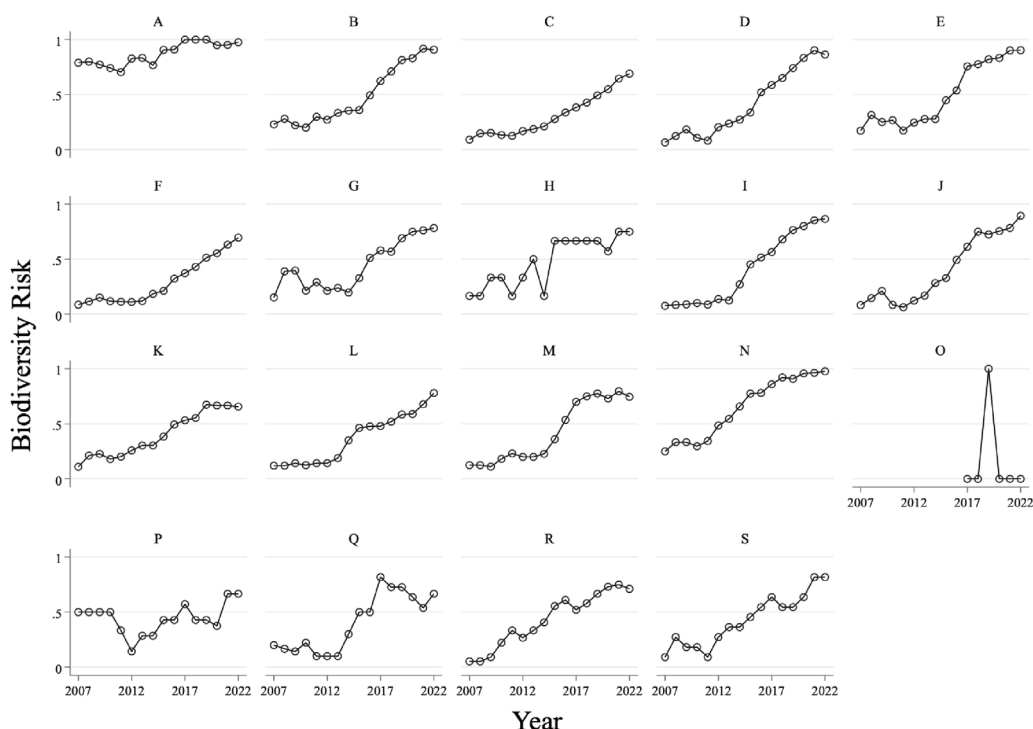
Fig. 3. Biodiversity Risk Index over time by industry.

2015. Since then, corporate attention to biodiversity has remained consistently high. These policies emphasized the importance of biodiversity conservation, introducing specific action frameworks and safeguard measures to promote green development and ecological civilization. The smooth upward trajectory of the Chinese corporate indicators and the high incidence are remarkable. Indeed, when one considers that typically a 10k report, from which the USA data are drawn, will include more detail on risks than will an annual report, the difference is even more stark. In the USA, per (Giglio et al., 2023) the mean level is 2%–5% per annum with a dip in the latter years.

Biodiversity conservation involvement varies across industries. Table 1 presents descriptive statistics of biodiversity indices for 19 sectors of listed companies in China, while Fig. 2 shows industry averages, categorized according to the 2012 guidelines of the China Securities Regulatory Commission.

The agriculture, forestry, animal husbandry, and fishery sector demonstrates the highest mean in the Biodiversity Risk Index at 0.8866 (indicating 88.66% of companies were given an index of 1), followed by the water conservancy, environmental, and public facilities management sector at 0.7585 (75.85% of companies given an index of 1). These two sectors also have the highest means in the Biodiversity Concern Index, indicating that Sectors A and *N* show the highest exposure to biodiversity risks and heightened concern for biodiversity. In contrast, (Giglio et al., 2023) found that energy, utility, and real estate sectors have the highest average biodiversity risk exposures in the United States. Both countries show a focus on biodiversity within the utility sector, likely due to environmental regulations on species and habitat protection affecting industry operations and costs. However, China's agriculture, forestry, animal husbandry, and fishery sector pays greater attention to biodiversity, while in the US, it is the energy and real estate sectors. This difference may stem from varying economic development stages and policy orientations.

Our data shows that the residential services, repairs, and other services sector, comprising only one company, demonstrates the least concern for biodiversity. Most other sectors exhibit roughly equivalent biodiversity index levels.

Figs. 3 and 4 illustrate temporal trends of biodiversity indices across the 19 sectors. Most sectors show an upward trend in the Biodiversity Risk Index, with the agriculture, forestry, animal husbandry, and fishery sector consistently maintaining high annual levels. The Biodiversity Concern Index reveals a clear upward trend only in the agriculture, forestry, animal husbandry, and fishery sector and the water conservancy, environmental, and public facilities management sector, while other sectors remain relatively stable.

4.2. Robustness check

To validate the effectiveness of the Biodiversity Risk Index and Biodiversity Concern Index, we compared it with the Climate Policy Uncertainty Index calculated by Ma et al. (2023).
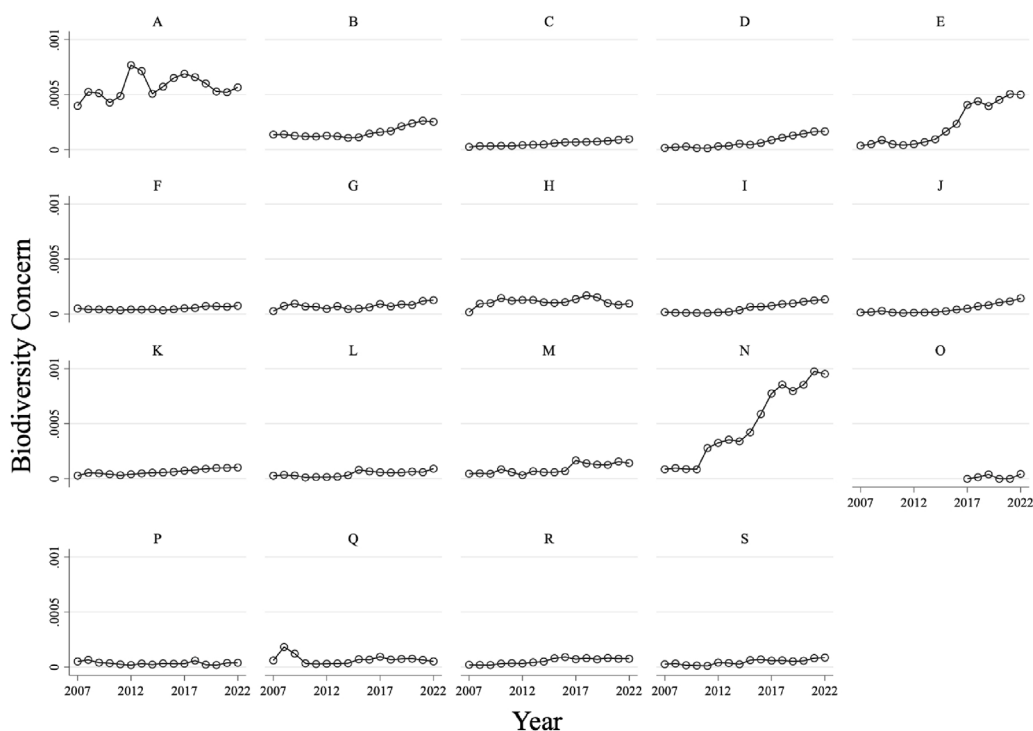
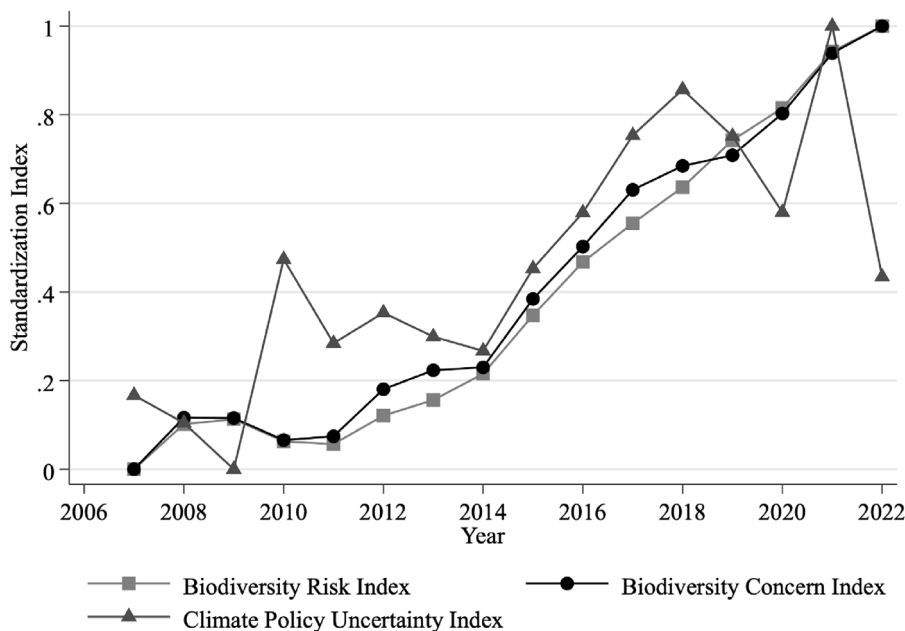**Fig. 4.** Biodiversity Concern Index over time by Industry.

Fig. 5. Is this just Climate?.

After standardizing both indices, we performed a comparison, as shown in Fig. 5. The results suggest that there is no consistent trend between changes in climate policy and biodiversity indices, suggesting that corporate actions on biodiversity protection are not directly influenced by shifts in climate policy. Therefore, we conclude that the Biodiversity Risk Index and Biodiversity Concern Index are valid and effectively represent the level of corporate attention to biodiversity conservation. This finding echoes that of Giglio et al. (2023).

5. Conclusions

We have developed and presented two indices of corporate biodiversity risk in the context of Chinese firms. Our findings, around the Biodiversity Risk index which is most directly comparable to the Giglio index, suggest that the great majority of chinese firms are taking cognizance of this area, an order of magnitude more than is the case for US companies. Why should this be so? The Belt and Road Initiative (BRI) contains significant sustainability (including biodiversity) elements. While enforcement of these can be critiqued (Bohnett et al., 2022) we argue that the very existence in such a program of national priority serves as a powerful spur to corporates to at least consider issues around biodiversity. The BRI was launched in 2013 and we note in Fig. 1 that it is in 2014–5 that the indices really began to rise. As these are annual reports and thus have a 12–18 m lag from action to report this is congruent. In addition, with significant government-led initiatives, Chinese biodiversity science has become a world player (Mi et al., 2021). This, combined with increasing Chinese public awareness of biodiversity issues (Millard et al., 2021) should also play a role. In the USA it has long been acknowledged (Hunter and Brehm, 2003) that a fragmented, NGO led drive towards environmental and biodiversity awareness has hampered widespread knowledge acquisition. We now have several measures, publically and privately available, which attempt to measure corporate biodiversity exposure. What is missing however is a formal adoption of biodiversity reporting. Initiatives such as the Taskforce on Nature-Related Financial Disclosures are forming a consensus bringing together natural capital accounting, nature related finance issues and regulators towards a set of standardized reports. Absent regulatory requirements however adoption is likely to be haphazard.

CRediT authorship contribution statement

Feng He: Project administration, Data curation. **Longxuan Chen:** Writing – original draft, Formal analysis. **Brian M. Lucey:** Methodology.

Data availability

Data available via link in the paper.

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