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Linking Mineral Rents, Resource Depletion, Biodiversity Conservation, and Public–Private Partnerships in Water and Sanitation Management

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ABSTRACT

Natural resources remain central to economic growth and social welfare, yet managing them sustainably continues to be a major challenge for countries striving to balance development with environmental protection. This study examines how mineral rents, mineral depletion, total natural resource rents, and public–private partnership (PPP) investment in water and sanitation interact and influence biodiversity conservation in China between 1980 and 2022. The results show that PPP investment in water and sanitation plays a positive role in biodiversity protection by improving water quality, easing environmental pressure, and promoting better management of ecological resources. In contrast, mineral rents and overall natural resource rents are negatively associated with biodiversity, highlighting the ecological risks that arise when resource exploitation intensifies. Mineral depletion also affects biodiversity loss, although its interaction with PPP investment suggests that coordinated efforts between public and private sectors can help soften some of the environmental costs linked to extraction. Overall, the findings point to the need for China to build a more integrated policy framework that links mineral rent management, depletion control, and biodiversity conservation. Such a framework should include mechanisms for evaluating the environmental and economic trade-offs of resource extraction and for promoting strategies that protect biodiversity while supporting long-term sustainable development.

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Research Highlights

- Mineral rents, biodiversity, protected areas, and water-sanitation partnerships are examined.
- Depletion occurs when a resource is extracted over time.
- Diverse plant and animal species make up biodiversity.
- Public-private partnerships can greatly enhance biodiversity conservation in China.

1. Introduction

Mineral rents are a type of revenue derived from the mining sector. This excess value is rent, which is what the owner of the resource gets on top of the cost of taking it out of the world. Depletion means a decrease in the quantity of natural resources due to production every year. Mineral rents, on the one hand, provide producers an incentive to invest more in exploration and extraction activities, which in turn lead to a higher level of production and, therefore, a lower natural rate of use of the resource. Overexploitation of natural resources also leads to their exhaustion [1]. They are used to describe the value added to the natural resource after extraction, which exceeds the production cost. Assessing mineral rent requires the calculation of market value, cost of extraction, regulation/transaction costs, etc. Investors have an incentive in this sector as long as mineral rents are present, and the prospect of a large return motivates spending on R&D, technological advancement, and infrastructure improvements. This investment can enhance productivity and efficiency, resulting in higher production and lower depletion rates. Nevertheless, enormous extraction has its price; natural resources are being exhausted. While mineral rents may drive exploration and extraction, these are nonrenewable resources, so long-term growth must come from other parts of the Central Asian economy. Excessive usage of natural resources can leave few or no resources for future generations. The impact on the environment might be severe, ranging from habitat destruction and air and water pollution to loss of biodiversity [2].

The degradation of natural resources can also adversely affect the economy. The same land value cannot be collected again on any depleted resource (mineral rents) that declines with the resource on which it depends. Such a reduction in government revenue and economic instability affects the financial stability of resource-rich countries [3]. Extraction industries risk losing jobs and other sectors may lack raw materials to produce their goods. As such, the relationship between mineral rents and depletion is not one-dimensional [4]. On the other hand, mineral rents can provide necessary incentives to invest in exploration and extraction activities that can increase production and reduce depletion rates. However, over-extraction of natural resources can lead to their depletion, which is harmful to both the environment and the economy. A balance between maximizing beneficial resource extraction and preserving natural resources is necessary for sustainable economic growth and environmental sustainability [5].

Biodiversity refers to the variety of plant and animal species in an ecosystem. The preservation of complex ecosystems is crucial for human well-being. Protected areas are defined and managed to protect ecosystems and their conserved species, minimizing risks from activities like logging, harvesting, fishing, hunting, and vehicular movement. Protecting these areas helps safeguard biodiversity and the continued existence of many plant and animal species.

Biodiversity and the services provided by ecosystems, such as pollination, soil fertility, and climate regulation, are intricately linked [6, 7]. As shown in Figure 1, the trends over time for biodiversity (A), total natural resources (B), and public-private partnership investments in water and sanitation (C) illustrate significant shifts from 1980 to 2020. These visual trends underscore the evolving dynamics between environmental conservation and economic activity, highlighting the challenges of balancing resource extraction with biodiversity protection. Biodiversity-rich ecosystems also protect landscapes and regions from severe weather events. Protecting the world's most complex ecosystems within protected areas provides opportunities for public engagement and stewardship [8].

Public-private partnerships (PPPs) are long-term contracts between the government and private companies to do things like build infrastructure, manage natural resources, use industrial biotechnology, and do genetic engineering. PPPs have been able to solve long-standing problems in water and sanitation, such as water scarcity and dilapidated infrastructure. By using the best parts of both the public and private sectors, PPPs may make things more efficient, creative, and cost-effective [9].

Natural resources are important for both people and the environment. They are used to make food, power, and infrastructure. Safeguarding these resources guarantees they remain intact and can be restored [10].

In developed countries, policymakers often make rules to stop people from using resources in ways that aren't sustainable. In developing countries, on the other hand, local communities can play a big role in managing resources in a way that is sustainable [11]. It is critical for communities, governments, and NGOs to work together to manage natural resources well. Although there is a lot of study on mineral rents, resource depletion, and biodiversity, there aren't many studies that look at how they all work together in the context of China's water and sanitation management. Furthermore, the function of public-private partnerships (PPPs) to reconcile resource extraction, environmental preservation, and economic advancement is still inadequately examined.

This paper examines the relationships among mineral rents, resource depletion, biodiversity conservation, and the function of public-private partnerships (PPPs) in China, offering empirical information to inform sustainable resource management and policymaking. Although mineral rents, resource depletion, PPP investment, and biodiversity have been studied, particularly in relation to China, most existing research treats these issues separately. Most of the existing research treats these issues separately, which makes it difficult to see how pressures from resource extraction, the expansion of water and sanitation infrastructure, and environmental protection interact in practice. By examining these variables jointly, this study offers a more connected view of the forces that shape biodiversity outcomes in a resource-dependent economy. This integrated approach helps clarify how economic gains from extraction and investment may also create ecological tensions and where opportunities for better conservation policies may lie.

This study also adds a methodological dimension. I employ Johansen's cointegration technique to explore how the main variables move together over the long term, which helps show whether their relationship is stable or temporary. This research used the ML-ARCH model to capture how fluctuations, rather than just levels, in mineral rents, resource depletion, and PPP investments affect biodiversity. Earlier studies rarely account for this volatility, even though sudden shocks in extraction or investment can have real ecological consequences. Bringing these two methods together allows the analysis to reflect both long-run patterns and short-run instability, providing a clearer picture of the environmental dynamics at play.

2. Literature Review

2.1. Mineral Rents and Depletion

The extraction of mineral resources is often the largest source of income for certain countries and companies as described by [12]. This is called mineral rents, which are the excess income generated by natural resources that still exceed production costs. Depletion, the slow but inevitable reduction in the overall quantity and, eventually, quality of a resource due to extraction, plays at the margins. Many studies are concentrating on how mineral rents and depletion interact with each other [13–16]. Taken together, these studies hint that mineral rents (whatever their precise source) facilitate the kind of resource-bust practices that mine neo-classical and classical analysts to talk of the resource curse. The study [17] has shown that the depletion of resources leads to lower revenues generated from mineral rents and could trigger economic instability and negative impacts on the environment and local communities.

Mineral rent—the economic potential and profitability of the extraction of minerals [18] and depletion, which is an irreversible reduction of minerals over time from extraction. Clearly, an in-depth understanding of each of these is vital for policymakers, investors, and stakeholders in the mining industry to rationalize and decide accordingly on the management of exploitable resources and the practice of sustainability [19]. The study [20], in which responsible mining practices balance economic goals with environmental and social goals, makes it possible to study the mineral rents and depletion by looking at the factors that affect them. Additional studies have also emphasized the cyclical behavior of mineral rents, their exposure to global shocks, and their long-term implications for resource-rich economies [21, 22]. Other research links depletion with governance quality and institutional strength [23].

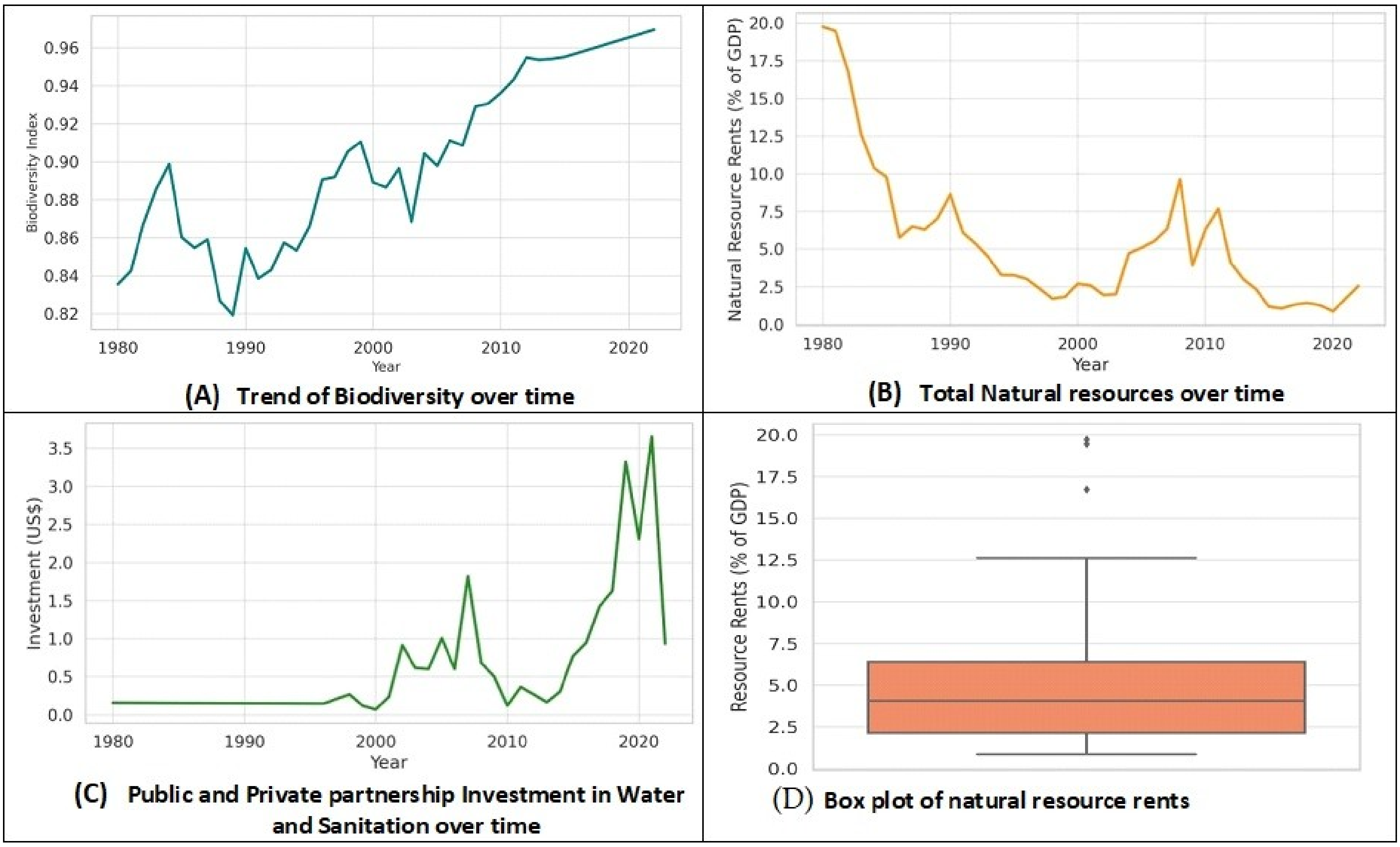

Figure 1. Different Trends over time (1980–2020) in (**A**), (**B**), and (**C**). Box plot of natural resources rent in (**D**).

2.2. Biodiversity and Protected Areas

Biodiversity was used in the study to mean the variety and richness of life forms on earth, including plants, animals, microorganisms, and the limitless diversity of ecosystems [24]. It is crucial for the health of our planet and human societies, and as such, it deserves our greatest focus and protection. Biodiversity is important for many reasons, including carbon sequestration, nutrient cycling, pollination, and structure and function integrity of ecosystems [25]. Protected areas continue to be an essential tool for our conservation and protection of the natural world as we confront the many challenges of biodiversity loss and environmental degradation. The literature that links these areas to biodiversity saved [26] surrounds biodiversity and protected areas and has been reviewed in various studies [27–30]. Such studies can assess the ability of protected areas to conserve biodiversity, the threats that they are susceptible to, and the opportunity for their expansion. It also discusses the importance of local communities and other partners in the management of biodiversity within protected areas [31]. We must act now to protect and restore biodiversity to the causes of biodiversity loss and not because of wildlife and ecosystems but because of the essential services ecosystems provide, which provides both people and wildlife, without which it provides neither. A study conducted by [32] suggested that inbreeding depression and loss of genetic diversity are at the top of threatened species. Recent work also explores how protected areas contribute to climate mitigation, landscape connectivity, and long-term species persistence [33, 34].

Despite the extensive research reviewed above, very few studies jointly examine mineral rents, resource depletion, biodiversity, and the role of PPPs—particularly within China. This gap highlights the need for an integrated empirical assessment, which this study provides.

3. Research Methodology: Theory and Model Development

Economic rentals of minerals are the cash flow that is generated as a result of extraction of minerals/oil/gas. This is an amazing source of government revenue, and it could be a step in the direction of better economic development. Mineral extraction does involve some environmental damage and the exhaustion of natural resources. Mineral rents and depletion are linked in theory through the extraction process [35]. In the course of mineral extraction, some methods can hurt ecosystems and decrease the amount of natural resources. Clearing land, using heavy machinery, and releasing toxins may kill off huge swaths of the biodiversity in the affected area [36].

Biodiversity means the variety of plants and animals in an area. Hence, it has a significant role in maintaining ecosystem balance and life sustainability on the planet. Protected area—an area set aside for the conservation of biodiversity, such as a national park or wildlife reserve [36]. The theoretical relationship between biodiversity and protected areas: since biodiversity is maintained by protecting natural habitats, this should lead to an increase in the probability of a species occurring in protected areas (dashed line). Governments and other relevant stakeholders create protected areas, but mineral exploration in or near the reserve could upset that balance and put the ecosystem's critical biodiversity at risk [32].

This requires that natural resource considerations be integrated with social, environmental, and economic concerns in decision-making processes [37]. This jointly explores the theoretical connection between what states may contribute and manage in regard to natural resources and the theoretical connection between mineral rents, biodiversity, and public/private partnerships. Careful extraction of resources, conservation, and sustainable development are essential to bringing together and managing natural resources [38]. Governments and other stakeholders can use this mechanism to ensure that the interests of any person are given equal weight within the scales and that this does not come at the expense of local communities or the environment in the name of economic development [1].

The histogram in Figure 2A shows that the Biodiversity Index is concentrated between 0.85 and 0.95, with a slight rightward shift, indicating a general improvement in biodiversity levels across most observed years. Figure 2B, illustrates a negative relationship between resource rents and biodiversity, where declining resource rents (% of GDP) over time correspond with a steady improvement in the Biodiversity Index, suggesting reduced exploitation benefits ecological recovery.

3.1. Data Sources

This paper examines the impact of natural resource rents, mineral rents, mineral depletion, and public–private partnership investment in water and sanitation on biodiversity conservation in China from 1980 to 2022. Annual data for all variables were obtained from well-established international sources. Mineral rents (% of GDP), total natural resource rents (% of GDP), and mineral depletion (% of GNI) were sourced from the World Development Indicators (WDI) of the World Bank. Biodiversity and protected area indicators were collected from the UNEP-WCMC and the World Database on Protected Areas (WDPA). Data on public–private partnership investment in water and sanitation were collected from the World Bank Private Participation in Infrastructure (PPI) Database. All data used in this study are publicly accessible, and proper citations are provided in the tables and references.

3.2. Model Specification

This paper examines the impact of natural resource rents, mineral rents, mineral depletion, and public-private partnership investment in water and sanitation on biodiversity conservation in China from 1980 to 2022.

$$\text{LOGB} = f(\text{LOGT}, \text{LOGM}, \text{LOGMD}, \text{LOGIN}) \quad (1)$$

Biodiversity conservation (LOGB) is modeled as a function of total natural resource rents (LOGT), mineral rents

(LOGM), mineral depletion (LOGMD), and public–private partnership investment in water and sanitation (LOGIN). All variables are transformed into natural logarithms to stabilize variance and improve estimation properties.

3.3. Unit Root Testing (ADF Test)

The data is assumed to follow a random walk process. To determine the order of integration of each variable, the Augmented Dickey–Fuller (ADF) test (Dickey & Fuller, 1997) is applied. The standard ADF regression is as given in (2).

$$\Delta y_t = \propto + \beta_t + \gamma y_{t-1} + \sum_{i=1}^{p} \delta_i \Delta y_{t-i} + \epsilon_t \quad (2)$$

where:

y_t: Variable under investigation
Δ: first-difference operator
p: Optimal lag length
γ: Coefficient tested for unit root

The null hypothesis is that the series contains a unit root (non-stationary). Rejection of the null indicates stationarity.

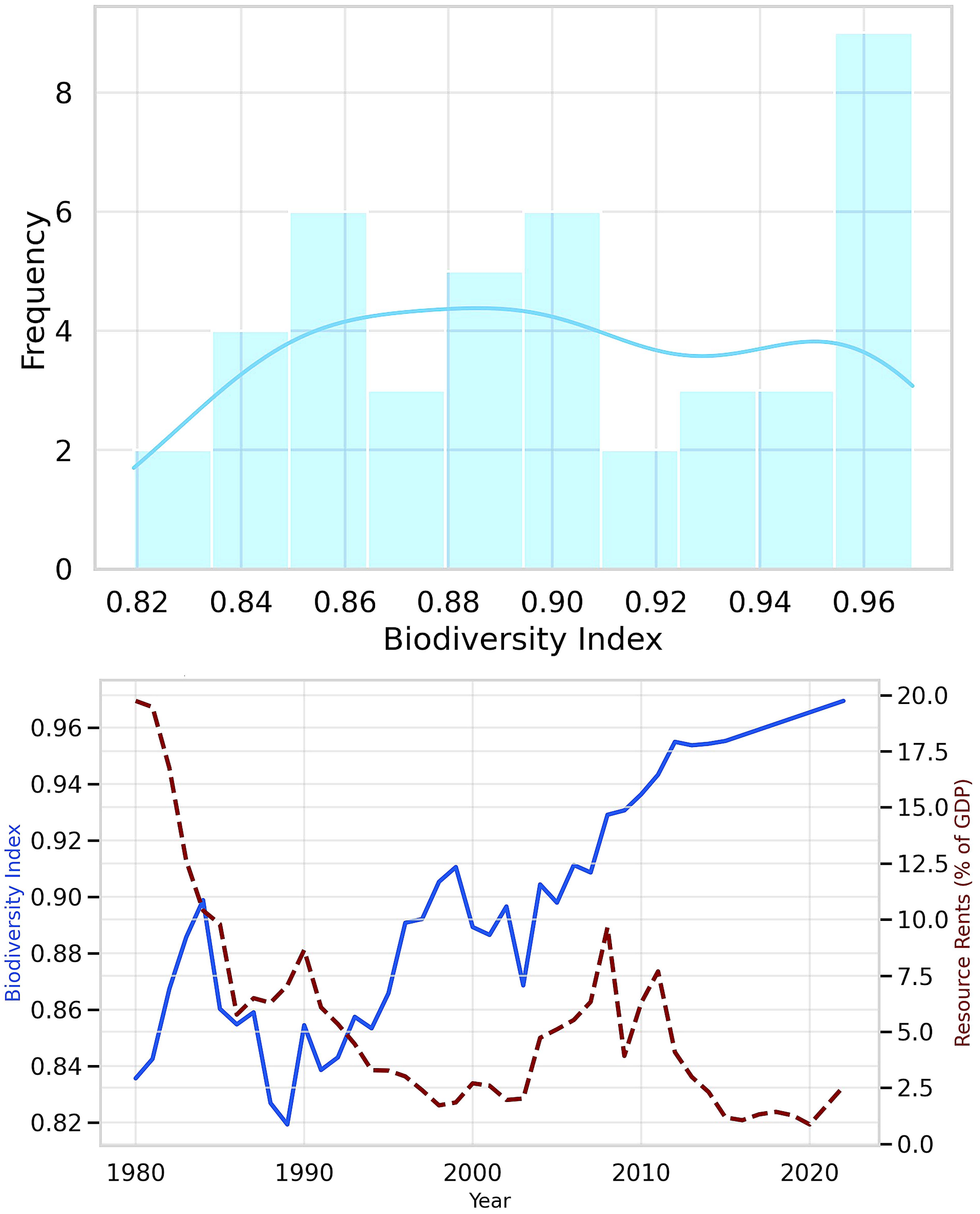

Figure 2. Comparative trend: Biodiversity vs Natural Resource Rents.

3.4. Johansen Cointegration Test

To examine long-run relationships among the variables, the **Johansen (1988)** cointegration test is applied. The test is based on the following vector error-correction model:

$$\Delta X_t = \pi X_{t-1} + \sum_{i=1}^{pk-1} \tau_i \Delta X_{t-i} + \mu + \epsilon_t \quad (3)$$

$$\Delta X_t = (\text{LOGB, LOGT, LOGM, LOGMD, LOGIN}) \quad (4)$$

The symbol π matrix contains long-run cointegrating relationships while τ_i is short-run dynamic coefficients.

Trace and Max-Eigen Statistics: The Johansen method provides two key statistics:

1. **Trace Statistic**

   Tests whether the number of cointegrating vectors is less than or equal to *r*.

   If the statistic exceeds the critical value, the null is rejected.

2. **Max-Eigen Statistic**

   Tests whether the number of cointegrating relations is exactly r against the alternative of $r + 1$.

   A significant result indicates an additional cointegrating relationship.

In this study, significant trace and max-eigen values indicate that biodiversity, mineral rents, depletion, and PPP investment share a long-run equilibrium relationship.

3.5. ARCH Test

The ARCH (Autoregressive Conditional Heteroskedasticity) test is employed to evaluate whether the variance of residuals is dependent on past error terms. This helps identify time-varying volatility in the model. Ensuring the absence of ARCH effects improves the robustness and reliability of the estimated model.

4. Results and Discussion

In Table 1, the descriptive statistics biodiversity conservation, mineral depletion, and public-private partnership investment in water and sanitation have similar modes and medians are explained. All of them need effective ways to reach their specific targets, and the median lies in the stakeholder collaboration and united efforts. But they are appreciably different in scope, focus, and scale. Sustainable policies can only be achieved with a thorough understanding of the differences and similarities among strategies that ensure biodiversity conservation, mineral resource security, and improvements in drinking water and sanitation infrastructure. The standard deviation is the least, 0.021965, in the case of biodiversity conservation. This indicates that the standard deviation of the measured data is smaller than that of other categories. The result was potentially indicative of a greater ability to achieve reliability in the biodiversity-conservation data than in other study areas. The standard deviations of mineral depletion and rents are 0.347403 and 0.384730. These values measure the spread or variability of the population or data that is under scrutiny. Standard Deviation—gives an idea of the uncertainty level or the spread of your data. It shows how far apart values are from the average (mean or average). When calculating the standard deviation, it factors in outliers, so it confirms the full spectrum of the variance in the data. Standard iterations work in any number of fields, like statistics, economics, and others. They provide insight into the spread or dispersion of the values linked to these two concepts in the specific context of mineral depletion and mineral rents.

Table 1. Descriptive Statistics.

	LOGB	LOGIN	LOGM	LOGMD	LOGT
Mean	−0.046009	8.532445	−0.376819	−0.622505	0.598642
Median	−0.046764	8.325105	−0.403289	−0.643744	0.611563
Maximum	−0.013490	9.562843	0.373319	0.240625	1.295381
Minimum	−0.086547	7.859739	−0.903569	−1.365295	−0.063600
Std. Dev.	0.021965	0.446552	0.347403	0.384730	0.350387
Skewness	−0.035994	0.770817	0.567405	0.461131	0.097447
Kurtosis	1.765818	2.413095	2.632566	2.858579	2.258799
Jarque-Bera	2.738362	4.875297	2.549187	1.559769	1.052359
Probability	0.254315	0.087366	0.279545	0.458459	0.590858
Sum	−1.978394	366.8951	−16.20322	−26.76773	25.74161
Sum Sq. Dev.	0.020263	8.375165	5.068946	6.216720	5.156388
Observations	43	43	43	43	43

Source: Author's estimation.

The scatter plot shows a positive relationship between adjusted savings and the biodiversity index, suggesting that higher national savings and investment in sustainable development are associated with improved biodiversity outcomes have shown in Figure 3A. The density plot indicates a negative relationship between total natural resource rents and biodiversity, where higher resource rents (% of GDP) are generally associated with lower biodiversity levels, highlighting the ecological costs of intensive resource extraction in Figure 3B.

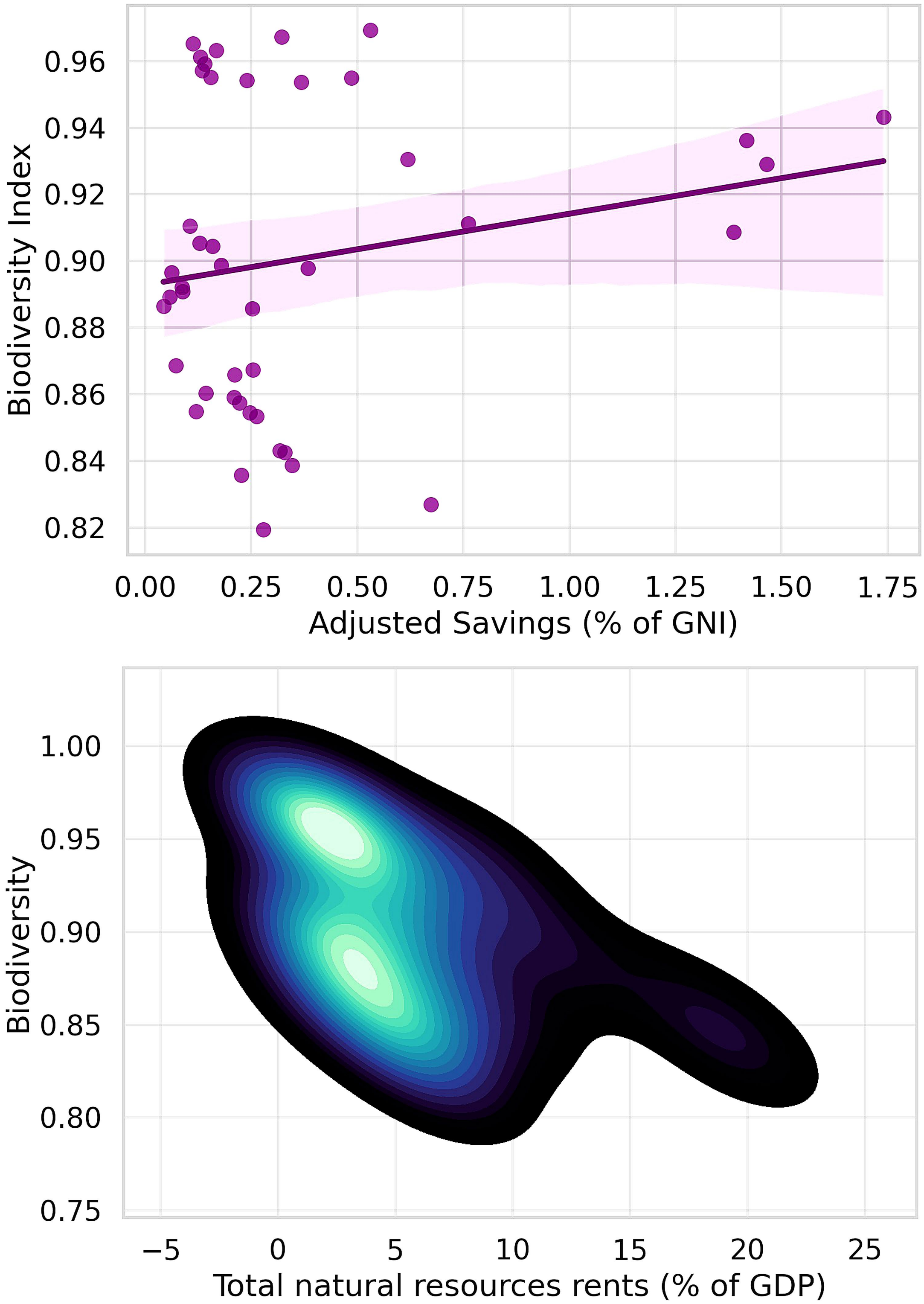

Figure 3. In (**A**) The scatter plot shows a positive relationship between adjusted savings and the biodiversity index (**B**) density plot indicates a negative relationship between total natural resource rents and biodiversity.

The results of covariance analysis for the features are presented in Table 2. These have a negative covariance of −0.004607. Total natural resource rents and biodiversity conservation Negative covariance (−0.004607): In this case, when one variable changes, the changes are opposite. This means that countries are less likely to adopt biodiversity conservation if the total natural resource rents increase and vice versa. Just because covariance is negative does not mean that one variable causes the other to change. It simply means that there is a statistical relationship; changes in one variable tend to occur with-or about with-changes in the other variable. Nonetheless, the specific cause-and-effect relationship may not be fully understood. If you conserve both mineral resources and biodiversity, then we say the covariance is positive. A reduction in biodiversity follows the exhaustion of mineral resources. This relationship is consistent with the fact that mineral extraction can cause environmental impacts. Mining disruptions destroy habitats, disturb ecosystems, and displace wildlife species. When land is cleared for mining, it involves the destruction of habitats that are usually rich in biodiversity forested, wetland, or grassland areas. Modern mining techniques, such as heavy machines or blasting and the use of chemicals, readily impact the affected area's biodiversity as well. Such activities will disrupt soil structure and water cycles, and pollute water bodies, thus threatening the loss of aqua biodiversity. Furthermore, the spillover effects of mineral extraction can also affect biodiversity. Infrastructure such as roads, pipelines, and power lines enables the movement of invasive species and encourages illegal hunting and poaching.

Table 3 shows that in the ADF unit root test. A time series that does not display long-run trends and has no cyclical elements is referred to as a stationary time series. The Adam Dickey-Fuller, or simply the ADF unit root test, analyzes time series data to see if it is non-stationary by using what is known as a unit root. The ADF unit root test is employed to identify if the level of mineral depletion is stable or if there is a hidden trend or seasonality, etc. The indicators of biodiversity conservation, public-private partnerships investment in water and sanitation, mineral rents, and total natural resources are stationary at a certain level. These changes result from various factors, including climate change, human activities, market dynamics, and natural processes. To protect these vital landscape features and keep them perennial, it is important to realize these changes, and composite measures must be taken.

The analysis Johansen Cointegration test results are presented in Table 4. These results shed light on the long-term relationships and adjustment dynamics among the variables that were analyzed, which include biodiversity conservation, total natural resource rents, mineral rents, mineral depletion, and public-private partnerships (PPPs) in water and sanitation. To determine if these variables are cointegrated, meaning they follow the same trend across time, we can look at the trace statistic and the max-eigen statistic. Cointegration is a statistical phenomenon whereby two or more variables tend to move in tandem over time due to shared causes, such as the interplay of macroeconomic, environmental, and policy variables.

Table 2. Covariance Analysis: Ordinary.

Covariance	LOGB	LOGIN	LOGM	LOGMD	LOGT
LOGB	0.000471				
LOGIN	0.006440	0.194771			
LOGM	0.000432	−0.002382	0.117882		
LOGMD	0.000930	0.011432	0.125795	0.144575	
LOGT	−0.004607	−0.083038	0.054299	0.059918	0.119916

Source: Author's estimation.

Table 3. Augmented Dickey-Fuller test statistic.

Methods/Variables	At-Level		At-First difference	
	t-Statistic	Prob.	*t*-Statistic	Prob.
LOGB	−0.860201	0.7907	−7.570125***	0.0000
LOGIN	−1.869011	0.3432	−7.134452***	0.0000
LOGM	−2.257728	0.1900	−5.923662***	0.0000
LOGMD	−2.885008*	0.0563	−5.423331***	0.0001
LOGT	−2.125395	0.2361	−6.097502***	0.0000

Source: Author's estimation ***, and * show significance at 1% and 10%.

Table 4. Johansen Cointegration Test Summary.

Selected (0.05 level*) Number of Cointegrating Relations by Model					
Data Trend	**None, No Intercept, No Trend**	**None, Intercept, No Trend**	**Linear, Intercept, NO Trend**	**Linear Intercept, Trend**	**Quadratic, Intercept, Trend**
Trace	0	0	0	1	2
Max-Eig	0	0	0	0	0
Information Criteria by Rank and Model					
Rank or No. of CEs	None, No Intercept, No Trend	None, Intercept, No Trend	Linear, Intercept, NO Trend	Linear Intercept, Trend	Quadratic, Intercept, Trend
Log Likelihood by Rank (rows) and Model (columns)					
0	227.4825	227.4825	229.5819	229.5819	230.6809
1	239.1773	241.2488	243.3149	246.0092	247.0718
2	244.8798	251.9996	253.9374	259.1739	260.2049
3	249.2209	257.5144	259.4125	268.3590	268.8786
4	251.1920	261.6426	263.3690	273.4133	273.6280
5	251.1965	263.6067	263.6067	275.8606	275.8606
Akaike Information Criteria by Rank (rows) and Model (columns)					
0	−9.877196	−9.877196	−9.735702	−9.735702	−9.545409
1	−9.959869	−10.01214	−9.917801	−10.00045	−9.857163
2	−9.750233	−9.999980	−9.948168	−10.10605*	−10.00999
3	−9.474189	−9.732410	−9.727437	−10.01751	−9.945298
4	−9.082538	−9.397200	−9.432637	−9.727480	−9.689170
5	−8.594950	−8.956423	−8.956423	−9.310273	−9.310273
Schwarz Criteria by Rank (rows) and Model (columns)					
0	−8.832335*	−8.832335*	−8.481869	−8.481869	−8.082603
1	−8.497063	−8.507538	−8.246023	−8.286879	−7.976413
2	−7.869483	−8.035641	−7.858446	−7.932735	−7.711300
3	−7.175495	−7.308332	−7.219771	−7.384464	−7.228659
4	−6.365899	−6.513384	−6.507026	−6.634692	−6.554587
5	−5.460367	−5.612868	−5.612868	−5.757746	−5.757746

Source: Author's estimation. * show significance at 1%, 5% and 10% respectively.

With the use of the trace statistic, we can see that there are cointegrating links between the variables, which means that we can reject the null hypothesis that there is no cointegration. When the trace statistic doesn't reveal enough about a relationship, the max-eigen statistic steps in to fill in the gaps. Based on our findings, the trace statistic points to a considerable cointegrating link between the variables, suggesting that they are not independent but rather subject to shared long-run influences. But there doesn't seem to be good proof of more than one cointegrating link in the max-eigen statistic, so it's possible that these variables aren't being driven by several underlying long-term forces.

Thus, this finding lends credence to the idea that shared variables are consistently impacting conservation efforts related to biodiversity, rents from natural resources, and other relevant metrics. Discovering these connections helps shed light on the mechanisms that control the ever-changing nature of ecosystem sustainability and natural resource management. The findings of this cointegration analysis in the realm of public-private partnerships (PPPs) investments in water and sanitation are crucial for developing appropriate policy responses. These responses must consider the interconnections among factors like mineral extraction, biodiversity conservation, and infrastructure development. The findings illustrate the impact of policy changes or mineral rents on ecosystem health and public-private investment strategies, among other factors. The cointegration results reinforce the long-term assumption that these variables are interconnected. Policymakers have the opportunity to address the interconnectedness of environmental, economic, and infrastructure issues by recognizing these relationships and formulating more holistic strategies.

The ML-ARCH model in Table 5 strengthens these findings by showing that volatility in mineral rents, resource rents, and PPP investment also has significant effects on biodiversity. Rather than changing the direction of the relationships, this model highlights how fluctuations especially sudden increases in resource rents intensify biodiversity loss, while more stable PPP investment tends to support conservation. This additional evidence confirms that not only the levels of extraction and investment matter, but also their stability over time.

Higher investment in water and sanitation (in % of GDP) with a 1% increase in public-private partnerships, investment in water and sanitation increases biodiversity conservation in China by 0.006112%. In this context, water and sanitation is an area where PPPs can vastly contribute positively. Governments, businesses, and non-profit organizations can collaborate to build water and sanitation infrastructure to address China's critical water challenges while also restoring China's biodiversity. While the relationship between PPPs and biodiversity conservation in China is complex, ongoing research and case studies shed light on this issue. PPPs can directly create favorable conditions for biodiversity conservation by investing in water and sanitation infrastructure.

The biodiversity conservation in China is reduced by −0.047438% when mineral rents increase by 1%. This data supports the view that increases in mineral rents are associated to a lesser extent with efforts to protect and sustain biodiversity. That is alarming as biodiversity and ecosystem health and sustainability are actually negatively correlated. On the one hand, mineral rents are a source of valuable financial resources for resource-rich developing countries; on the other hand, they could also represent an important source of environmental degradation. Biodiversity: the extraction and use of minerals often result in habitat destruction (as plants and animals are cleared from the site), land clearing around mining operations (releasing so-called edge effects), and other forms of pollution that can degrade sites and reduce biodiversity with wider impact. There are a number of reasons why greater mineral rents cause less biodiversity conservation. For one, the revenue from extractive activities can create an incentive to value short-term economic returns over long-term preservation. In the second place, the mining itself can damage biodiversity in the area. Particularly concerning for the environment are the ecosystem disruptions and threats to the survival of various plant and animal species that can happen as a result of the clearing of land for mines, the use of toxic chemicals, and the disposal of mine waste. Loss of biodiversity, of course, affects the functioning of the ecosystem and has broader implications on ecosystem services, which are services, provided to society by biodiversity, for example, pollination, pest regulation, and cycling of nutrients.

Mineral depletion increases China's biodiversity conservation relatively by 0.059303% if the 1% increment is assumed. Biodiversity Conservation: A significant loss of mineral resources is driven by mines in China. Changes in the mineral composition that disappear, such as copper, zinc, nickel, etc., although this is exaggerated far from possible consequences on ecosystems and biodiversity. Habitats are fast disappearing, soil is constantly being washed away, and more pollution is being generated as minerals are mined in bulk. It is a complex relationship between mineral depletion and biodiversity conservation. Meanwhile, mineral extraction can offer economic opportunities and create jobs. If there is a downside, it is in the costs acquired by biodiversity and the environment. Econometric analysis provides one means to assess the impact of mineral depletion on biodiversity conservation. The relationship between mineral depletion and variation in biodiversity conservation was measured to offer an insight into the relationship between the two variables.

Table 5. Method: ML ARCH—Normal distribution (BFGS/Marquardt steps).

Variable	Coefficient	Std. Error	*z*-Statistic	Prob.
LOGIN	0.006112**	0.002108	2.899735	0.0037
LOGM	−0.047438*	0.026431	−1.794813	0.0727
LOGMD	0.059303**	0.022940	2.585077	0.0097
LOGT	−0.027882***	0.003101	−8.990416	0.0000
C	−0.028718	0.018608	−1.543350	0.1227
		Variance Equation		
C(7)	0.002233***	0.000640	3.486005	0.0005
C(8)	0.235152*	0.123113	1.910045	0.0561
C(9)	0.674635*	0.403186	1.673262	0.0943
C(10)	−0.176892*	0.098487	−1.796089	0.0725
C(11)	1.281357***	0.011507	111.3559	0.0000

Source: Author's estimation. ***, ** and * show significance at 1%, 5% and 10% respectively.

Natural resource rents as a percentage of GDP an increase of 1%—reduces the level of biodiversity conservation in China by -0.027882%. This inverse relationship suggests that higher natural resource rents may theoretically free up resources for conservation efforts, such as through funding for protected area management, habitat restoration, and scientific research. However, a Chinese study indicated that as total natural resource rents grow, biodiversity conservation decreases. This negative relationship implies a trade-off between conservation and resource extraction. While increased resource rents may provide more financial resources, they often increase the exploitation of natural resources, leading to environmental degradation. Overexploitation results in habitat destruction, fragmentation, and degradation. For example, as forests are cleared for agriculture or mining, the natural habitats of species are lost, causing displacement and reducing habitat availability, which can be harmful to biodiversity.

5. Conclusion and Policy Implications

China has travelled a long distance in this very competitive field and, within a very brief time, has set a precedence record to resolve some of the concerns associated with natural resources and sustainability. The results of the present research may offer a better understanding of the complicated relationships between mineral rents and depletion rates, biodiversity in protected areas, public–private partnerships in water and sanitation management, and the management of natural resources. The deficit between the domestic supply and demand, over-dependence on importation of raw materials like minerals to produce modern and high polarization, and its anxiety over energy security and depletion of ore are all indicators of the necessity for the sustainable development of local mining companies. The findings of the paper imply that mineral rents are positively related to higher depletion rates, and that regions of China that have higher mineral rents deplete at higher rates. This implies that the natural resources of these regions may end even faster because of the intensified mineral extractions. The nation needs to strike a balance between economic growth and environmental conservation to avoid over-exploitation of resources and ensure sustainability. Thus, policy programs should be implemented to address this issue, such as:

- Introducing more stringent regulations on resource extraction to slow down the depletion of high-rent areas.
- Promoting sustainable mining practices through incentives for companies that adopt greener technologies.
- Investing in renewable energy research and development to reduce reliance on mineral resources and address energy security concerns.

The conservation of biodiversity in China assists in maintaining the balance of ecology within the country and leads to the long-term exploitation of natural resources. The current study indicates that the relationship between biodiversity and the presence of protected areas is positive, meaning that China has more biodiversity in regions where protected areas exist. It turns out that in the context of biodiversity conservation, the concept of protected areas seems to be especially topical, and it is significant to guarantee the ability of ecological systems to respond to new conditions. To better safeguard biodiversity, the government should consider the following:

- Expanding the network of protected areas to meet the Convention on Biological Diversity targets and preserve critical ecosystems.
- Increasing the implementation and enforcement of environmental laws to protect these areas from illegal exploitation.
- Promoting sustainable land use programs that include local community engagement to enhance the long-term success of protected areas.

Many people in China are yet to enjoy access to better water and sanitation services, which is a daunting challenge faced by China. The findings of this study indicate that these challenges can be addressed through public-private partnerships (PPPs), which could improve infrastructure for water and sanitation. China needs to have a clear legal framework, appropriate financing for private sector participation, and a fair distribution of responsibilities and benefits in order to capture the synergy of PPPs in water and sanitation resources. The government should also provide capacity-building and technical assistance to local authorities and the private sector so they can become effective coordinators and managers of the PPPs.

China has emerged as one of the key players regarding the management of natural resources in the world arena. The study findings indicate the implications of China for the conservation and recovery of biodiversity and ecology in the world are substantial. In an attempt to increase the role played by China in the management of natural resources, the country ought to direct its efforts towards:

- Sustainable land management practices that encompass restoration of degraded ecosystems, biodiversity conservation, and better management of water resources.
- Engagement in international natural resource management mechanisms, such as becoming more involved in international forums and initiatives to collaborate on global sustainability efforts.

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Conflicts of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Use of AI and AI-Assisted Technologies

During the preparation of this work, the author has not used AI-assisted technologies.

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