1 Source of ESG Topic

Pillars	Themes	Key Issues	Source
Environment	Climate change	Carbon emissions	CSI
Environment	Climate change	Response to climate change	CDP
Environment	Natural capital	Water resources	CDP
Environment	Natural capital	Biodiversity	CDP
Environment	Natural capital	Land use	GRI
Environment	Natural capital	Raw materials	GRI
Environment	Natural capital	Energy and resource consumption	GRI
Environment	Sustainable development management	Waste management	GRI
Environment	Sustainable development management	Green finance	CSI
Environment	Sustainable development management	Clean technology	GRI
Environment	Sustainable development management	Green building	New indicator
Environment	Sustainable development management	Environmental policy	CSI
Environment	Sustainable development management	Sustainable certified	CSI
Environment	Sustainable development management	Environment penalizes	CSI
Social	Product responsibility	Product quality	CSI
Social	Product responsibility	Data Safety	MSCI
Social	Product responsibility	Chemical safety	CDP
Social	Product responsibility	Responsible Investment	GRI
Social	Stakeholders	Employees	CSI
Social	Stakeholders	Customers	GRI
Social	Stakeholders	Promotion Employment	GRI
Social	Stakeholders	Supply chain management	SASB
Social	Stakeholders	Public Welfare and Volunteer service	GRI
Social	Stakeholders	Rural assistance	New indicator
Social	Stakeholders	Anti-epidemic	New indicator
Governance	Corporate governance	Technology innovation	MSCI
Governance	Corporate governance	Organizational structure and operation	GRI
Governance	Corporate governance	Information Disclosure and Communication with investors	Bloomberg
Governance	Corporate governance	Audit	SASB
Governance	Business ethics	Reporting system	SASB
Governance	Business ethics	Shareholder and creditor rights	SASB
Governance	Business ethics	Legal proceedings and external sanctions	MSCI
Governance	Business ethics	Anti-illegitimate competition	SGF
Governance	Business ethics	Property protection	MSCI
Governance	Business ethics	Tax transparency	SASB
Governance	Business ethics	Anti-corruption and anti-money laundering	CSI

Table 1: ESG Topics and Key Issues.

We establish the ESG topics and key issues according to the standards of internationally recognized third-party organizations, including the Global Reporting Initiative (GRI)[1] [1], the Sustainability

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[1]https://www.globalreporting.org/

Accounting Standards Board Foundation (SASB)[2] [5], the Carbon Disclosure Project (CDP)[3] [3], Morgan Stanley Capital International (MSCI)[4] [2], Bloomberg [5] [6], the China Securities Index (CSI)[6] [9], and SynTao Green Finance (SGF)[7] [10]. Additionally, in line with the regulatory requirements for ESG report disclosures by listed companies, and considering both the contextual background and the actual content disclosed by these companies, we include categories such as Green Building, Rural Assistance, and Rural Education as new indicators.

2 Model details

	LERT	PERT	BERT	RoBERTa (base)	RoBERTa (large)	LLaMA 2
Hidden	768	768	768	768	1024	4096
Layer	12	12	12	12	24	4
Attention head	12	12	12	12	16	32
Trainable params	0.1M	0.1M	0.1M	0.1M	0.2M	0.4M
All params	0.1B	0.1B	0.1B	0.1B	0.3B	1.03B
Trainable params (%)	0.10%	0.10%	0.07%	0.09%	0.07%	0.04%
runtime(s)	429.20	802.32	981.80	965.78	1107.13	5623.03

Table 2: Model detail.

All the foundational models utilized in this research are derived from the Chinese pre-trained models provided by HFL on the Hugging Face. The Chinese pre-training corpus encompasses a wide array of data resources, including but not limited to Chinese Wikipedia dump, encyclopedia, community question answering, and news articles. For detailed information and access to resources, please refer to `https://huggingface.co/hfl`.

In terms of trainable parameters in table Table 2, LLaMA2 boasts 2M trainable parameters, far exceeding the others, yet it has the lowest percentage of trainable parameters at just 0.03%.

3 Dataset details

In the quality classification task, figure Figure 1 demonstrates that the distribution of qualitative text significantly dominates the dataset, surpassing other texts by a considerable margin. The proportion of irrelevant text is relatively minimal, aligning closely with the structural composition of ESG reports. In the ESG reports, irrelevant text such as 'In case of discrepancies between the English and Chinese versions, the Chinese version shall prevail' and 'Please provide an overall evaluation of this report' constitutes only a minor share, while the majority of the content is predominantly qualitative.

Figure Figure 2 presents the dataset distribution for the topic classification task. To ensure accuracy and reliability in the ESG topic classification, we have labeled a minimum of 25 sentences for each topic.
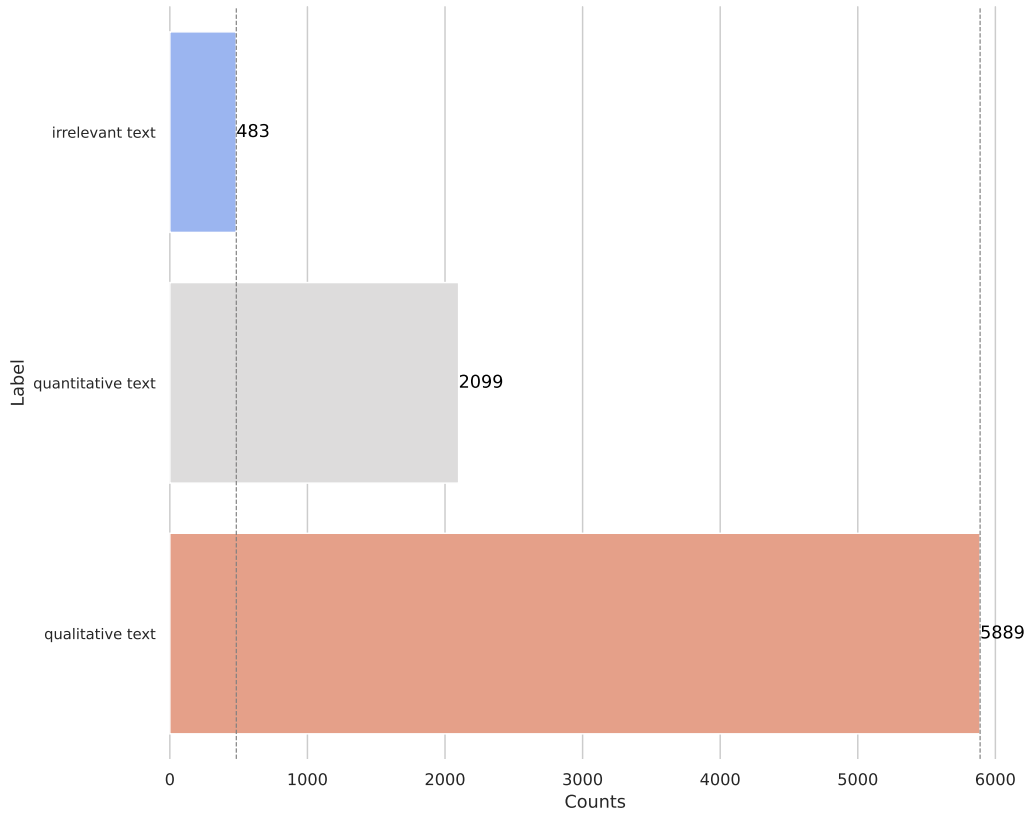
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[2]https://sasb.ifrs.org/

[3]https://www.cdp.net/en

[4]https://www.msci.com/

[5]https://www.bloomberg.com/

[6]https://www.csindex.com.cn/en#/

[7]https://www.syntaogf.com/

Figure 1: Distribution of qualitative text.
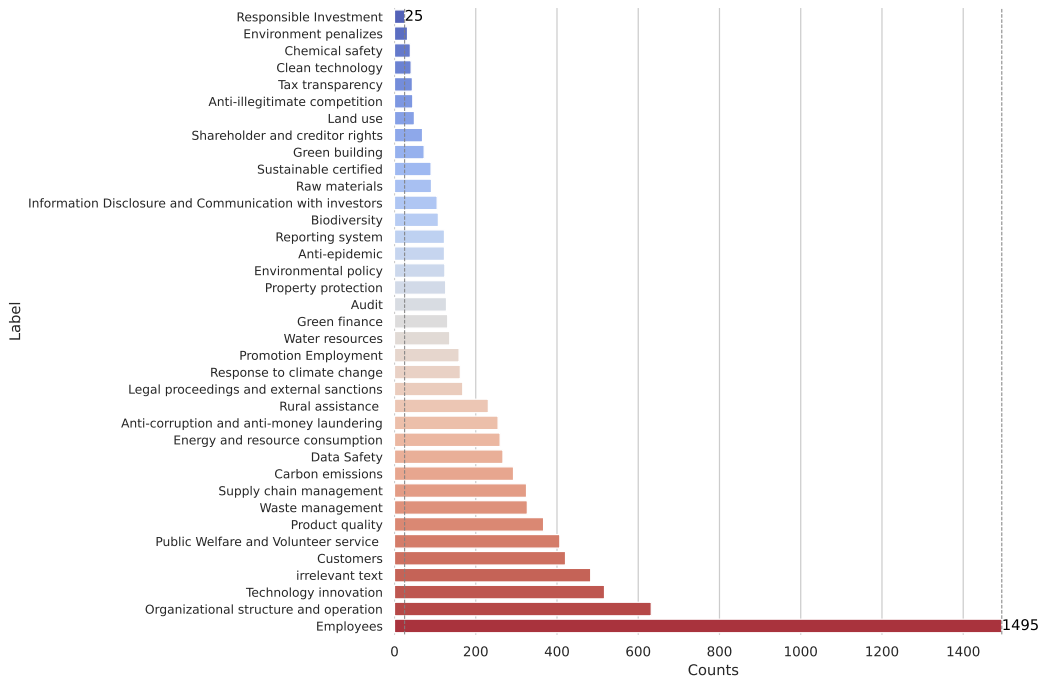
Figure 2: Distribution of topic text.

4 PEFT results

	LoRA	P-tuning	Prompt-tuning(soft)	Prompt-tuning (hard)
Config	r = 4, α = 32	tokens = 10	tokens = 10	prompt 3
Precision	83.56%	81.42%	78.37%	85.25%
Recall	77.72%	75.22%	71.22%	80.08%
F1	80.01%	77.14%	73.66%	81.54%
Accuracy	*84.89%*	83.17%	80.64%	**85.66%**

Table 3: Different PEFT performance on LLaMA2.

We leverage Parameter-Efficient Fine-Tuning methods such as Prompt-Tuning [7], LoRA [4] and P-Tuning [8]. We conducted a comparative analysis of the performance of different PEFT methods based on LLaMA2. As shown in Table 3, we tested four fine-tuned configurations on the topic classification task. Employing various fine-tuning strategies on the LLaMA2 model has a marginal impact on performance. In this experiment, the Prompt-tuning (hard) method stood out, achieving the highest accuracy at 85.66%.

5 Prompt design

Prompt 1: Classify the ESG report text by topic.

Prompt 2: The ESG report comprises 3 first-level indicators, 7 second-level indicators indicators, and 36 third-level indicators. As a logical ESG report analyst, you classify the ESG text according to the third-level indicators.

Prompt 3: The ESG report comprises 3 first-level indicators, 7 second-level indicators, and 36 third-level indicators, organized in a tree structure:Environment: Climate Change: [Response to Climate Change, Carbon Emissions], Natural Capital: [Land Use, Biodiversity, Raw Materials, Energy and Resource Consumption, Water Resources], Sustainable Development Management: [Clean Technology, Sustainable Certification, Green Finance, Environmental Penalties, Green Building, Waste Management, Environmental Policy], Social: Product Responsibility: [Data Safety, Product Quality, Responsible Investment, Chemical Safety], Stakeholders: [Employees], Stakeholders: [Supply Chain Management, Employment Promotion, Rural Assistance, Public Welfare and Volunteer Service, Customers and Consumers, Anti-Epidemic Measures], Governance: Corporate Governance: [Audit, Organizational Structure and Operation, Technological Innovation, Information Disclosure and Investor Communication], Business Ethics: [Intellectual Property Protection, Legal Litigation and External Sanctions, Anti-Unfair Competition, Whistleblower System, Shareholder and Creditor Rights, Anti-Corruption and Anti-Money Laundering, Tax Transparency]. As a logical ESG report analyst, you classify the ESG text according to the third-level indicators.

Prompt 4: Classify the ESG report text by quality.

Prompt 5: As a logical analyst of ESG reports, you classify the quality of ESG texts into three categories: quantitative texts, which include numerically quantified ESG content; qualitative texts, referring to descriptive ESG narratives; and irrelevant texts, such as indexes, English sections, and other non-essential ESG content.

Prompt 6: The keywords related to ESG are:Environment: Climate Change: [Response to Climate Change, Carbon Emissions], Natural Capital: [Land Use, Biodiversity, Raw Materials, Energy and Resource Consumption, Water Resources], Sustainable Development Management: [Clean Technology, Sustainable Certification, Green Finance, Environmental Penalties, Green Building, Waste Management, Environmental Policy], Social: Product Responsibility: [Data Safety, Product Quality, Responsible Investment, Chemical Safety], Stakeholders: [Employees], Stakeholders: [Supply Chain Management, Employment Promotion, Rural Assistance, Public Welfare and Volunteer Service, Customers and Consumers, Anti-Epidemic Measures], Governance: Corporate Governance: [Audit, Organizational Structure and Operation, Technological Innovation, Information Disclosure and Investor Communication], Business Ethics: [Intellectual Property Protection, Legal Litigation and External Sanctions, Anti-Unfair Competition, Whistleblower System, Shareholder and Creditor Rights, Anti-Corruption and Anti-Money Laundering, Tax Transparency]. As a logical ESG report analyst, you classify the ESG text into two quality categories: (1) Quantitative text related to ESG that contains numerical quantification, (2) Qualitative text related to ESG that is descriptive.

Figure 3: The prompts used in this work.

The design of prompts is pivotal in training language models, particularly in specialized domains. We incorporate the ESG tree's structure into the prompts to enhance classification accuracy.

In the "Topic classification prompt design," we structured the prompts to guide the model through a hierarchical framework of ESG indicators. This framework includes 3 first-level indicators, 7 second-level indicators, and 36 third-level indicators. This detailed structure ensures that the model captures the comprehensive scope of ESG topics, facilitating accurate classification.

Similarly, the "Quality classification prompt design" focuses on distinguishing between irrelevant, qualitative, and quantitative texts. This differentiation is crucial for evaluating the completeness and integrity of ESG reports.

6 Visualizations of completeness of ESG reports

6.1 Visual quality classification

Figure 4: Quality classification prediction on 2022 ESG reports.

Figure 4 depicts the distribution of text quality in the 2022 annual reports for 20 stocks, as predicted by the fine-tuned LLaMA2. The figure provides a percentage breakdown of the text types across all reports, with qualitative text making up the majority, followed by quantitative text, and a minimal portion of irrelevant text. Additionally, the visualization is consistent with the description in Appendix B: dataset details.
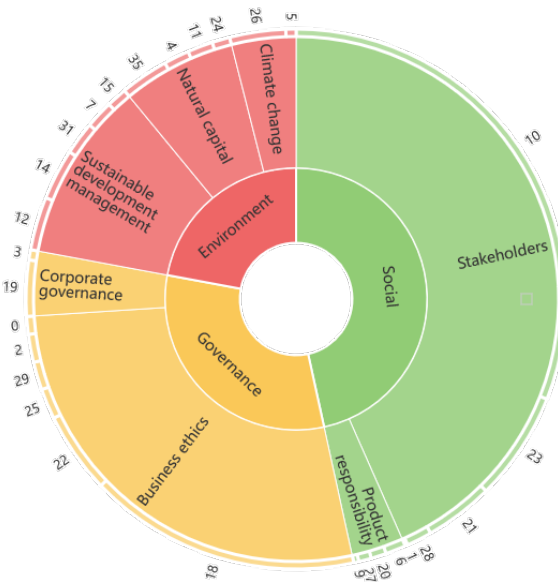
6.2 Visual reports of stock 000961.

Figure 5: Sunburst on 2022 ESG reports of stock 000961.

In Figure 5, we present a topic classification through a sunburst, taking the annual report of stock code 000961 as a case to demonstrate the visualization of its Environmental, Social, and Governance

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(ESG). The sunburst is structured in concentric circles, with the center circle representing the overall annual report. As the layers expand outward, they reveal a more detailed categorization, such as major categories including Environment, Social, and Governance, further divided into specific subcategories like Climate Change and Natural Capital. Different color segments indicate different categories, with the size of each segment reflecting the frequency of sentences within that category in the annual report. The company with the stock code 000961 pays greater attention to social and governance. The sunburst enables quick recognition of key areas and their comparative significance in the ESG disclosures.

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