The Construction of ESG Indexes by Integrating ESG Assessment into Smart Beta Strategies

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Abstract

ESG investing is gaining popularity, but the range of investment products available could still be widened, especially in China. The main reason is that how to effectively incorporate ESG assessments into the decision-making process for investments poses a big challenge. Therefore, this study aims to incorporate ESG assessment into investment strategies from two stages in the investment process: stock screening and weight allocation. Six smart beta strategies are examined to construct ten smart beta indexes. Performance evaluation for the 2018–2022 period in Hong Kong reveals significant enhancement in index performance compared to the Hang Seng Index. This study highlights the importance of ESG factors in investment, showing superior performance of all ten indexes, notably the DESGI30 and Net-Yield Weighted indexes. These findings offer insights for sustainable investors in China, guide fund managers in green investment product development, and contribute to ESG performance literature.

Keywords:

ESG Investing; ESG Assessment; Smart Beta Strategy; ESG Index; Hong Kong Stock Market

1. Introduction

Sustainable investing has seen remarkable expansion in the worldwide financial market, which considers environmental, social, and governance (ESG) factors in portfolio selection and management (Serafeim & Yoon, 2022). Since the launch of the United Nations Principles for Responsible Investment (PRI) in 2005[1], the number of signatories has grown from 734 in 2010 to 5319 in 2022, with total assets under management of US$121 trillion in 2022[2]. Companies with high ESG assessment are typically in a stronger position to address regulatory challenges, reduce legal disputes, and manage environmental risks effectively. (Filbeck et al., 2019).

However, despite the rising interest in ESG among global investors, many are uncertain about how to channel their funds to companies that act responsibly and sustainably. Currently, the majority of ESG fund assets remain concentrated in Europe. In the Global Sustainable Fund Assets of 2022, Europe accounted for $2,078 billion in ESG fund assets, while China had only $50 billion[3]. This poses a challenge for investors in China who are interested in ESG investments. One of the main reasons for this phenomenon is that China lags behind the West regarding ESG investing, therefore the lack of information and insufficient knowledge cause Chinese investors have no idea how to integrate ESG factors into their investment strategies effectively (Tan et al., 2023).

As investors seek innovative approaches to navigate the ESG landscape, the adoption of smart beta strategies has emerged as a promising solution. Smart beta strategies, also known as alternative beta or factor investing, are hybrid management strategies (Dimson et al., 2017). They aim to provide the advantages of active strategies in terms of performance, while simultaneously maintaining numerous benefits associated with passive investing, such as cost-effectiveness, liquidity, and transparency. (Kahn & Lemmon, 2015). Therefore, these strategies combine traditional passive investment techniques with factor-based investing, offering a systematic and rules-based approach to incorporate ESG criteria into portfolios. As per the findings from the FTSE Russell Smart Sustainability Survey in 2020[4], 81% of asset owners in Europe, the Middle East, and Africa (EMEA), as well as 42% of those in North America, are looking to or have already applied ESG considerations to a smart beta strategy, while in China, relevant literature and empirical research are still sparse.

Therefore, to solve the dilemma faced by the investors in China, this study aims to construct ESG indexes by integrating ESG assessment into smart beta strategies, focusing on two stages in the investment process: stock screening and weight allocating. Specifically, this study examines six smart beta strategies to construct ten smart beta indexes integrating ESG assessment and evaluate their performance over the past five years in the Hong Kong context, a region in China that mandates annual ESG information disclosure for listed companies, which provides comprehensive and

[1] UNEP, 2005. A legal framework for the integration of environmental, social and governance issues into institutional investment. https://www.unepfi.org/fileadmin/documents/freshfields_legal_resp_20051123.pdf
[2] PRI, 2022. Signatory Update. www.unpri.org/download?ac=18057.
[3] Statista. Total assets under management (AUM) of sustainable funds worldwide from 2010 to 2022, by region. https://www.statista.com/statistics/1319691/sustainable-funds-aum-global-allocation/
[4] FTSE Russell. 2020. Smart Sustainability: 2020 Global Survey Findings from Asset Owners. https://www.ftserussell.com/index/spotlight/smart- sustainability- survey

authentic ESG data to ensure the practicality and reliability of the research.

In particular, this study aims to address four questions:

1) How to screen out companies with high ESG assessment?

2) How to integrate ESG factor into Smart Beta Strategies?

3) How to construct ESG Indexes to make the ESG investment more feasible for Chinese investors?

4) How to validate the feasibility of the ESG Indexes?

By taking the Hang Seng Index as the benchmark, this study firstly evaluates the ESG performances of related listed companies by applying an innovative Dual ESG Index framework and screens out 30 top-rated constituents based on the ESG assessment achieved. According to six smart beta strategies, this study assigns appropriate weights to each constituent and then constructs ten ESG indexes by integrating ESG assessment into six smart beta strategies. To validate the feasibility of the ESG Indexes, this study conducts a backtest on the historical performance of ten ESG indexes constructed based on different smart beta strategies and make the correlation analysis with existing ESG indexes to further prove the reliability of the ESG indexes constructed in this study.

The contributions of this study are summarized as follows: (1) This study Introduces a novel Dual ESG Index framework, enhancing ESG assessment with scalability and flexibility for evaluating Chinese companies. (2) By applying ESG scores in both stock screening and weight allocation processes, this study integrates ESG assessment into six smart beta strategies, offering academic insights and reinforcing the significance of ESG factors in the investment process. (3) This study constructed ten ESG indexes with different weight allocating strategies based on the Hang Seng Index, providing Chinese investors with practical and region-specific tools for diverse investment styles in ESG. (4) By backtesting the performance of ten ESG indexes constructed, this study obverses that the Net-Yield Weighted index and the DESGI30 index showed great performance among ten indexes, where the former achieved higher returns in prosperous market conditions, and the latter demonstrated stronger resilience during market downturns. These findings suggest the benefits of prioritizing good ESG performance for stability and risk reduction. The study also offers practical insights for fund managers in selecting suitable weight allocation methods.

The remainder of this paper is organized as follows. Section 2 presents the literature review. In Section 3 describes the data and method for Index construction and performance measurement. Section 4 focuses on the empirical results, where ten ESG indexes are constructed and evaluated based on six smart beta strategies. The conclusion and future insights follow in Section 5.

2. Literature review

This work is closely related to the literature about ESG investment and smart beta strategies.

2.1 ESG Investment

Many studies have been conducted on ESG investment strategies, yet the debate regarding whether ESG investments yield excess returns persists. Currently, there are

two perspectives among researchers. From a positive perspective, several studies have been conducted on the impact of ESG performance on investors. Giese et al. (2019) argued that ESG ratings enable investors to incorporate corporate sustainability performance into their investment strategies. Park & Oh (2022) also validated that individual investors do indeed consider ESG factors in their decision-making process. Furthermore, Dai Liyan et al. (2022) provided evidence, based on investment institutions, that higher ESG scores do attract sovereign wealth funds for investments. Moreover, numerous studies have examined the impact of ESG on corporate investment strategies from the perspective of the companies themselves. For example, Kong Ningning et al. (2023) investigated how ESG specifically influences the scale and efficiency of corporate investments, finding that ESG performance can lead to excess investment and that the level of excess investment is a reasonable investment in line with the company's development status, significantly enhancing the company's investment efficiency. Wang W et al. (2022) also, from the company's own perspective, demonstrated a positive correlation between ESG performance and investment efficiency and suggest that audit quality plays an intermediary role in this relationship. Broadstock et al. (2021) reported a similar finding using China's CSI300 components: during financial crises in the overall market, high ESG portfolios tend to outperform low-rated portfolios, confirming the risk-mitigating effect of ESG performance. Li et al. (2022) proposed an ESG-embedded indexing method, which has been shown to improve portfolio returns. Davoodi et al. (2024) also proved the possibility for companies to achieve higher returns while taking social responsibility into account by proposed an ESG-oriented portfolio model.

On the other hand, there are studies that present different perspectives. Halbritter (2015) and Humphrey (2012) assessed corporate sustainability using ESG ratings and corporate social performance scores but do not observe differences in returns between high and low-rated companies. While Hartzmark and Sussman (2019) found that U.S. foundations with higher sustainability tend to attract more funds, they do not find that these funds exhibit superior performance. Similarly, Renneboog et al. (2008) investigated that funds in Europe and the Asia-Pacific region experience lower performance after adjusting for ethical risks. Pedersen (2021) also found no direct evidence to suggest that ESG promotes company profits.

2.2 Smart Beta Strategy

Smart beta, as an investment strategy, combines traditional indexes with active management factors to enhance portfolio performance (Dimson et al., 2017). In this context, Beta reflects the returns earned for assuming systematic risk, while Alpha represents the excess return relative to the market average (Sharpe, 1964). Smart beta strategies employ various factors or variables to select and weight assets in a portfolio, rather than relying solely on market capitalization for fund allocation. These factors may include stock valuation, dividend yield, volatility, quality, momentum, and others (Kahn & Lemmon, 2016; Bender et al., 2014; Constantinides & Duffie, 1996). Consequently, smart-beta strategies harness the advantages of active investment strategies while retaining many benefits of passive investing (Dimson et al., 2017).

Comparatively, research on the integration of ESG and smart-beta strategies is relatively limited. A study by FTSE Russell[5] suggested an increasing convergence between smart-beta and ESG strategies. Subsequently, Kwan et al. (2017) and Xie, J et al. (2019) found that SRI strategies can provide higher returns to investors with reduced strategy risk in smart-beta portfolios. By integrating ESG factor into smart beta strategies, Stempler (2021) achieved a portfolio with returns of over 50 percent, while the benchmark EURO STOXX 50 only provided a 19 percent profit. Giese (2016) also proved that ESG factors can add financial value to portfolios and financial indexes and can be used the same way as or in addition to traditional common performance factors. However, Kahn and Lemmon (2016b), in combining ESG with smart-beta strategies, did not observe a significant improvement in portfolio performance. Tan (2023) evaluated how ESG affects portfolios constructed based on smart-beta in separate assessments conducted in Australia, mainland China, Hong Kong, Malaysia, and Singapore. The results also indicated that portfolios with strong ESG performance did not necessarily lead to improved investment performance.

In summary, there is still no definitive consensus on whether ESG performance has an impact on investors and the companies themselves, and the majority of research still focuses on the early development of sustainable investing in Europe and the United States, with limited studies in China. Therefore, whether investors can achieve excess returns or risk mitigation by incorporating ESG factors into their investment strategies still need to be verify. Moreover, although Western countries have begun to integrate smart beta strategies with ESG factors, research in China is still relatively limited. Investors are still unsure how to effectively engage in ESG investments, highlighting the urgent demand for a viable and easily referenced ESG investment strategy.

3. Data and method

This section begins with an introduction to the data of the Hang Seng Index constituent stocks. Then, the novel Dual ESG Index Model is introduced to evaluate the ESG performance of constituent stocks. Next, the strategies and processes for high-rated ESG stock screening are presented. The construction methods of six smart beta indexes are then described. Finally, the measurement method of index portfolio performance is introduced.

3.1 Data

Currently, more than thirty countries and regions have explicitly mandated listed companies to disclose ESG information. Some regulatory bodies require mandatory disclosure, such as Hong Kong in China and the United States. The European Union mandates a combination of voluntary and mandatory disclosure, while mainland China is still in the voluntary disclosure stage. Considering the data integrity, this study uses the Hang Seng Index as a benchmark and selects the constituent stocks of the Hang Seng Index as the stock pool for the stock selection model. Hang Seng Indexes Limited is regulated by the Hong Kong Stock Exchange, which requires listed companies to

[5] FTSE Russell. 2020. Smart Sustainability: 2020 Global Survey Findings from Asset Owners. https://www.ftserussell.com/index/spotlight/smart- sustainability- survey

disclose ESG information according to specified guidelines[6]. Companies listed in this index portfolio have relatively comprehensive and standardized ESG data disclosure, which could ensure the practicality and reliability of the research.

The ESG disclosure data of this paper is sourced from official disclosure documents provided by the companies. The disclosure frequency is once a year. Considering the availability of data and the variability of constituents in the Hang Seng Index, the selected time span for this study is five years, from 2018 to 2022. However, due to the fact that the ESG information disclosed by companies each year actually pertains to the previous year, the backtesting period for the stock selection model is from 2019 to 2023.

This section aims to simulate the stock selection process realistically. During the period from 2019 to 2023, there were multiple changes in the constituents of the Hang Seng Index, as shown in Table 1. Therefore, data collection and stock selection will be strictly conducted in accordance with the changes in the constituents of the Hang Seng Index starting from 2019.

As of 2023, there are 80 constituent stocks in the Hang Seng Index. The Hang Seng Industry Classification System[7] is a comprehensive industry classification system tailored to the conditions of the Hong Kong stock market. It comprises 12 industries, 31 business categories, and 96 business sub-categories. These 12 industries encompass financials, utilities, properties and construction, information technology, consumer discretionary, consumer staples, healthcare, industrials, energy, telecommunications, conglomerates, and materials. Table 2 shows the Hang Seng Industry Classification System of Year 2023.

In the Hang Seng Index constituents, Hong Kong-listed mainland companies and Hong Kong-listed common stocks constitute a significant proportion, accounting for 38.24% and 35.34% respectively. The industries of the Hang Seng Index constituents are primarily distributed in consumer discretionary sector (14 companies) and properties and construction sector (13 companies), accounting for 17.5% and 16.25% of the total weight respectively.

[6] HKEX. ESG Reporting Guide. https://www.hkex.com.hk/Listing/Sustainability/ESG-Academy/Rules-and-Regulations?sc_lang=en

[7] Hang Seng Industry Classification System. https://www.hsi.com.hk/eng/our-services/hsics

Table 1. Constituent Changes in Hang Seng Index between year 2019 to 2023

Effective Year	Effective Date	Change	Count	Stock Code	Stock Name	No. of Constituents After Change
2023	2023-06-05	Add	+4	2899.HK	ZIJIN MINING	80
				6618.HK	JD HEALTH	
				0836.HK	CHINA RES POWER	
				9961.HK	TRIP.COM - S	
2022	2022-12-05	Add	+3	1209.HK	CHINA RES MIXC	76
				0322.HK	TINGYI	
				6690.HK	HAIER SMARTHOME	
	2022-09-05	Add	+4	1088.HK	CHINA SHENHUA	73
				1929.HK	CHOW TAI FOOK	
				3692.HK	HANSOH PHARMA	
				9888.HK	BIDU - SW	
	2022-06-13	Add	+4	1378.HK	CHINAHONGQIAO	69
				0316.HK	OOIL	
				0881.HK	ZHONGSHENG HLDG	
				0981.HK	SMIC	
		Delete	-1	2018.HK	AAC TECH	
	2022-03-07	Add	+2	9633.HK	NONGFU SPRING	66
				0992.HK	LENOVO GROUP	
2021	2021-12-06	Add	+4	2688.HK	ENN ENERGY	64
				0291.HK	CHINA RES BEER	
				9618.HK	JD-SW	
				9999.HK	NTES-S	
	2021-09-06	Add	+3	2331.HK	LI NING	60
				3968.HK	CM BANK	
				0868.HK	XINYI GLASS	
		Delete	-1	3328.HK	BANKCOMM	
	2021-06-07	Add	+3	1211.HK	BYD COMPANY	58
				6098.HK	CG SERVICES	
				0968.HK	XINYI SOLAR	
	2021-03-15	Add	+3	0241.HK	ALI HEALTH	55
				6862.HK	HAIDILAO	
				0960.HK	LONGFOR GROUP	
2020	2020-12-07	Add	+3	1876.HK	BUD APAC	52
				2020.HK	ANTA SPORTS	
				3690.HK	MEITUAN-W	
		Delete	-1	0019.HK	SWIRE PACIFIC A	
	2020-09-07	Add	+3	1810.HK	XIAOMI-W	50
				2269.HK	WUXI BIO	
				9988.HK	BABA-SW	
		Delete	-3	1088.HK	CHINA SHENHUA	
				0151.HK	WANT WANT CHINA	
				0083.HK	SINO LAND	
2019	2019-03-11	Add	+1	0669.HK	TECHTRONIC IND	50
		Delete	-1	0836.HK	CHINA RES POWER	

Table 2. The Hang Seng Industry Classification System of Year 2023

Industry	Stock Code	Stock Name
Financials	0005.HK	HSBC HOLDINGS
	0011.HK	HANG SENG BANK

	0388.HK	HKEX
	0939.HK	CCB
	1299.HK	AIA
	1398.HK	ICBC
	2318.HK	PING AN
	2388.HK	BOC HONG KONG
	2628.HK	CHINA LIFE
	3968.HK	CM BANK
	3988.HK	BANK OF CHINA
Utilities	0002.HK	CLP HOLDINGS
	0003.HK	HK & CHINA GAS
	0006.HK	POWER ASSETS
	0836.HK	CHINA RES POWER
	1038.HK	CKI HOLDINGS
	2688.HK	ENN ENERGY
Properties & Construction	0012.HK	HENDERSON LAND
	0016.HK	SHK PPT
	0017.HK	NEW WORLD DEV
	0101.HK	HANG LUNG PPT
	0688.HK	CHINA OVERSEAS
	0823.HK	LINK REIT
	0960.HK	LONGFOR GROUP
	1109.HK	CHINA RES LAND
	1113.HK	CK ASSET
	1209.HK	CHINA RES MIXC
	1997.HK	WHARF REIC
	2007.HK	COUNTRY GARDEN
	6098.HK	CG SERVICES
Information Technology	0700.HK	TENCENT
	0981.HK	SMIC
	0992.HK	LENOVO GROUP
	1810.HK	XIAOMI - W
	3690.HK	MEITUAN - W
	9618.HK	JD - SW
	9888.HK	BIDU - SW
	9988.HK	BABA - SW
	9999.HK	NTES - S
Consumer Discretionary	0027.HK	GALAXY ENT
	0066.HK	MTR CORPORATION
	0175.HK	GEELY AUTO
	0669.HK	TECHTRONIC IND
	0881.HK	ZHONGSHENG HLDG
	1211.HK	BYD COMPANY
	1928.HK	SANDS CHINA LTD
	1929.HK	CHOW TAI FOOK
	2020.HK	ANTA SPORTS
	2313.HK	SHENZHOU INTL
	2331.HK	LI NING
	6690.HK	HAIER SMARTHOME
	6862.HK	HAIDILAO
	9961.HK	TRIP.COM - S
Consumer Staples	0288.HK	WH GROUP
	0291.HK	CHINA RES BEER
	0322.HK	TINGYI
	1044.HK	HENGAN INT'L
	1876.HK	BUD APAC
	2319.HK	MENGNIU DAIRY
	9633.HK	NONGFU SPRING
Healthcare	0241.HK	ALI HEALTH
	1093.HK	CSPC PHARMA
	1177.HK	SINO BIOPHARM
	2269.HK	WUXI BIO
	3692.HK	HANSOH PHARMA
	6618.HK	JD HEALTH
Industrials	0316.HK	OOIL
	0868.HK	XINYI GLASS
	0968.HK	XINYI SOLAR
	2382.HK	SUNNY OPTICAL
Energy	0386.HK	SINOPEC CORP
	0857.HK	PETROCHINA
	0883.HK	CNOOC
	1088.HK	CHINA SHENHUA
Telecommunications	0762.HK	CHINA UNICOM
	0941.HK	CHINA MOBILE
Conglomerates	0001.HK	CKH HOLDINGS
	0276.HK	CITIC
Materials	1378.HK	CHINAHONGQIAO
	2899.HK	ZIJIN MINING

3.2 ESG assessment method

Previous studies present many representative ESG assessment solutions from both industrial and academic fields. In the industry, large data providers and rating agencies

such as MSCI[8], Refinitiv[9], and Sustainalytics[10] have launched a variety of products and ESG rating services in demand. In the academic field, researchers also contribute to ESG assessment methodologies. For example, Zhou et al. (2012) developed a composite sustainability index to achieve the best combination for a normalization–weighting–aggregation scheme. More recently, Sokolov et al. (2021) proposed an approach to constructing the ESG index using news and social media data, combined with deep learning techniques for Natural Language Processing. However, due to different rating methodologies and data sources employed by various rating agencies and researches, there may be discrepancies in the rating scores assigned to the same company (Berg et al, 2022; Christensen et al, 2021). Existing methodologies are also facing the challenges of limited company coverage and inflexible ESG framework. Therefore, to achieve a comprehensive evaluation of ESG performance and make the ESG assessment method more suitable for the subject of this study, this paper proposes a novel Dual ESG Index (DESGI) as the model of the ESG assessment.

The DESGI model, borrows the rationale and concepts from the academic credit system, combines ESG credit and ESG GPA measuring the depth and width of corporate sustainability performance. It brings the advantages such as scalability and flexibility into ESG rating (Hasan and Parvez, 2015). To borrow the rationales and concepts from the academic credit system into the ESG ecosystem, this study made an analogy between the academic credit system and the ESG ecosystem, as shown in Table 3. In the academic credit system, the students need to enroll in the relevant courses and take the exams, while the teachers assess the student's academic performance. Moreover, total course credits and GPA are two key criteria to evaluate the students' academic performances. In the ESG ecosystem, likewise, the listed companies need to select relevant ESG metrics and conduct ESG reporting, while the ESG rating agencies assess the ESG index of the listed companies. Therefore, both systems share many similarities, and some concepts could be mirrored.

The academic degree is useful to provide employers with the recognition of students' professional levels. Likewise, ESG degree, as a positioning indicator, is designed to provide an incremental hierarchical ESG framework with four levels including diploma, bachelor, master, and doctor degree. For example, investors require an ESG master degree or above when investing in high-polluting manufacturing industries. The ESG degree is assessed by ESG rating agencies based on the earned ESG credits. The higher the ESG degree is, the wider the ESG disclosure is.

Table 3. Definition of Key Concepts in DESGI model

[8] MSCI,2020. MSCI ESG Ratings Methodology. https://www.msci.com/documents/1296102/21901542/MSCI+ESG+Ratings+Methodology+-+Exec+Summary+Nov+ 2020.pdf.

[9] Refinitiv, 2020. Environmental, social and governance (esg) scores from refinitiv. https ://www.refinitiv.com/content/dam/marketing/en_us/documents/methodology/re finitiv-esg-scores-methodology.pdf.

[10] Sustainalytics, 2021. ESG risk ratings methodology. https://www.sustainalytics.com /esg-data.

Key DESGI Concepts	Definition of DESGI Concepts	Concepts of Academic Credit System
ESG Curriculum	Refers to the guidelines with detailed requirements for an ESG degree	Curriculum
ESG Degree	Refers to a positioning indicator to demonstrate the ESG disclosure level	Academic Degree
ESG Course	Refers to the ESG metrics with their KPIs	Course
ESG Course Category	Distinguishes the ESG course into different course categories, i.e. Compulsory courses	Course Category
ESG Credit	Refers to the weight of an ESG course	Credit
ESG GPA	Refers to the overall GPA of all selected ESG courses	GPA

Moreover, in order to assess and compare companies from different sectors, DESGI model designed an industry-specific framework, based on the Hang Seng Index company industry classifications, to divide constituent companies into twelve industries for separate evaluation. In terms of setting ESG courses and specific KPIs, DESGI model refers to the ESG disclosure frameworks released by three different institutions: the Hong Kong Stock Exchange[11], the Global Reporting Initiative (GRI)[12], and the Sustainability Accounting Standards Board Foundation (SASB)[13]. This is done to expand the Bachelor's, Master's, and Doctorate level ESG courses across various industries. The specific design also adheres to the principles of setting university degrees, wherein higher ESG degrees require a greater number of ESG courses and consequently, more credits to be completed.

A ESG curriculum metrics example for consumer discretionary Industry is shown as Table 4. These course categories included public compulsory courses, public elective courses, industry compulsory courses, and industry elective courses. Courses in the latter two categories were designed specific to different industries. The white-filled courses, green-filled courses, and blue-filled courses correspond to bachelor's degrees, master's degrees, and doctorate degrees respectively. It is also worth noting that the ESG Curriculum metrics is a flexible framework that ESG courses can be added or removed at any time without affecting the overall ESG score, since the GPAs for each course are calculated independently. As a result, more corporate sustainability performances can be well distinguished by the DESGI framework.

[11] HKEX. ESG Reporting Guide. https://www.hkex.com.hk/Listing/Sustainability/ESG-Academy/Rules-and-Regulations.
[12] GRI Standards. https://www.globalreporting.org/standards.
[13] SASB Standards. https://sasb.org/standards/

Table 4. ESG Curriculum metrics for Consumer Discretionary Industry

Consumer Discretionary Industry	
ESG Course Category	ESG Course
Public Compulsory Courses	A2 GHG Emission
	A6 Climate change
	B1 Employment
	B4 Labour Standards
	B7 Anti-corruption
	C1 The governance structure and its composition
	C5 The role of governance body in sustainability reporting
	C6 The role of the highest governance body in evaluating economic, environmental and social performance
	A10 Products and Services
	C2 The role of the highest governance body in setting the organization's purpose, values, and strategy
	C3 The competencies and performance evaluation of the highest governance body
	A19 Compliance
Public Elective Courses	C4 The role of the highest governance body in risk management
	A11 Biodiversity
	C7 Remuneration and incentives
	C8 Business whistleblowing mechanism
	A5 The environment and natural resources
	A18 Water Pollution
	B13 Marketing Communications
	B14 Customer Privacy
Industry Compulsory Courses	A1 Gas emission (except GHG)
	A3 Use of Resources Water
	A4 Use of Resources Energy
	A7 Hazard emission
	A8 Non-hazard emission
	A9 Use of package material
	B2 Health and Safety
	B5 Supply Chain Management
	B6 Product Responsibility
	A12 Transport
	A13 Supplier Environmental Assessment
	A14 Environmental Grievance Mechanisms
	B9 Supplier Human Rights Assessment
	B10 Human Rights Grievance Mechanisms
	A10 Products and Services
	A15 Management of Chemicals in Products
	A17 Raw Materials Sourcing
	B11 Supplier Assessment for Labor Practices
	B12 Labor Practices Grievance Mechanisms
Industry Elective Courses	B3 Development and Training
	B8 Community Investment
	C9 Shareholder rights
	C10 Impartiality of the Nominating Committee

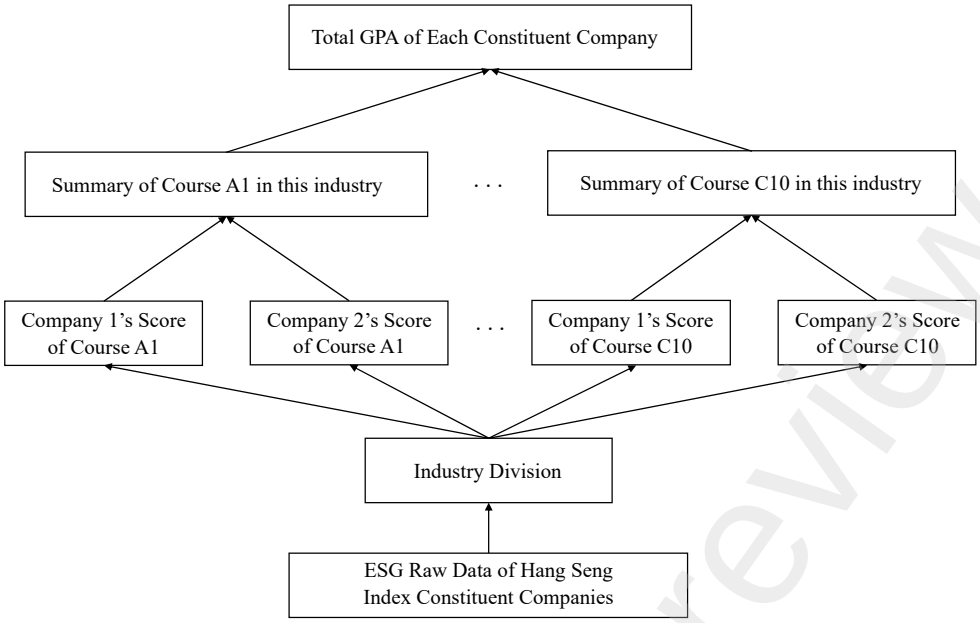

Figure 1. Process of ESG GPA determination

After the constituent stocks are classified into twelve industries according to the Hang Seng Index Industry Classification System, they will enroll in courses within their respective industry templates. Each course is equipped with 1-16 Key Performance Indicators (KPIs) to assess the ESG performance of companies within that course. The ESG data discoursed with each course can be divided into three types: Numerical, Boolean, and String. Firstly, numerical data contains the KPIs with two value types: benefit criteria (the larger, the better) and cost criteria (the smaller, the better). Secondly, Boolean data refers to the KPIs with the answer such as disclosed/non-disclosed, yes/no, and true/false. Thirdly, string data refers to the descriptive data in ESG KPIs, such as product responsibility, anti-corruption, etc. The three types of ESG data are preprocessed as the results of individual KPIs and are then aggregated and ranked to derive the scores for each company under that course. Subsequently, all companies within the industry will be ranked based on the summation of scores across all courses to obtain the final ESG GPA value for each company.

3.3 Screening of Constituents

3.3.1 Stock Screening Strategies

ESG-based stock selection strategies encompass various types, including positive screening, ESG integration, negative screening, sustainable thematic investments, etc. Among them, most worldwide institutional investors followed integration strategies for the implementation of ESG factors, which implemented by 66% of the respondents. Exclusionary screens and impact investments followed, implemented by 45% and 42% of the respondents, respectively[14]. Therefore, to enhance the practicality and persuasiveness of this study, this study first employs the positive screening strategy for the selection of constituent stocks, followed by the implementation of a smart-beta

[14] Statista. Main ESG strategies of institutional investors 2021. https://www.statista.com/statistics/1296375/how-institutional-investors-implement-esg/

strategy to adjust the weights of the selected constituent, forming the final ESG index. Since this study utilizes the DESGI model for evaluation to assess the top 30 ESG high-rated stocks, and the scores obtained from DESGI framework will play a decisive role in both screening and weight allocation process, for clarity, this study will refer to the ultimate index as the DESGI30 index.

In the stock screening process, this study introduces the DESGI model to assess companies ESG performances. The equation of DESGI model is as follows:

$$DESGI = \alpha * Credit/Ca + \beta * GPA$$

Credit refers to the weight of an ESG course, which are all the ESG credits obtained by the company, while Ca represents an ESG credit scaling parameter. GPA stands for the overall GPA of all selected ESG courses. α and β represent adjustable parameters for credit and GPA, which can be determined by investor preferences.

The obtained ESG credit values are classified into four ESG degrees, including Diploma, Bachelor's (100-150 credits), Master's (150-200 credits), and Doctorate (over 200 credits). To standardize and neutralize the impact between ESG credit and GPA in DESGI, ESG credits are divided by Ca, which is the minimum credits required for obtaining an ESG Diploma. The GPA follows a 4.0 credit system, where the GPA for each course is determined based on ranking. Only the top 5% of listed companies can obtain a GPA of 4.0. For listed companies ranking between 100% and 5%, the GPA is calculated based on their rankings. The GPA Value Conversion is shown as Table 5.

Table 5. GPA Value Conversion Table

GPA Value	Percentage Ranking
4.0	φ <= 5%
3.5	5% < φ <= 15%
3.0	15% < φ <= 30%
2.5	30% < φ <= 50%
2.0	50% < φ <= 70%
1.5	70% < φ <= 85%
1.0	85% < φ <= 95%
0	φ > 95%

Section 3.2 has already introduced the process of obtaining the course GPA of listed companies through the ESG Curriculum metrics. In practical assessments, following chronological order, the GPA was determined based on the ESG Curriculum metrics from 2019-2023, and the top 30 companies in DESGI scores were ultimately selected. It is worth noting that considering the continuous changes in the Hang Seng Index constituents (with several additions or deletions each year), data of same company from different years is entered into the metrics independently to make the ranking more accurate.

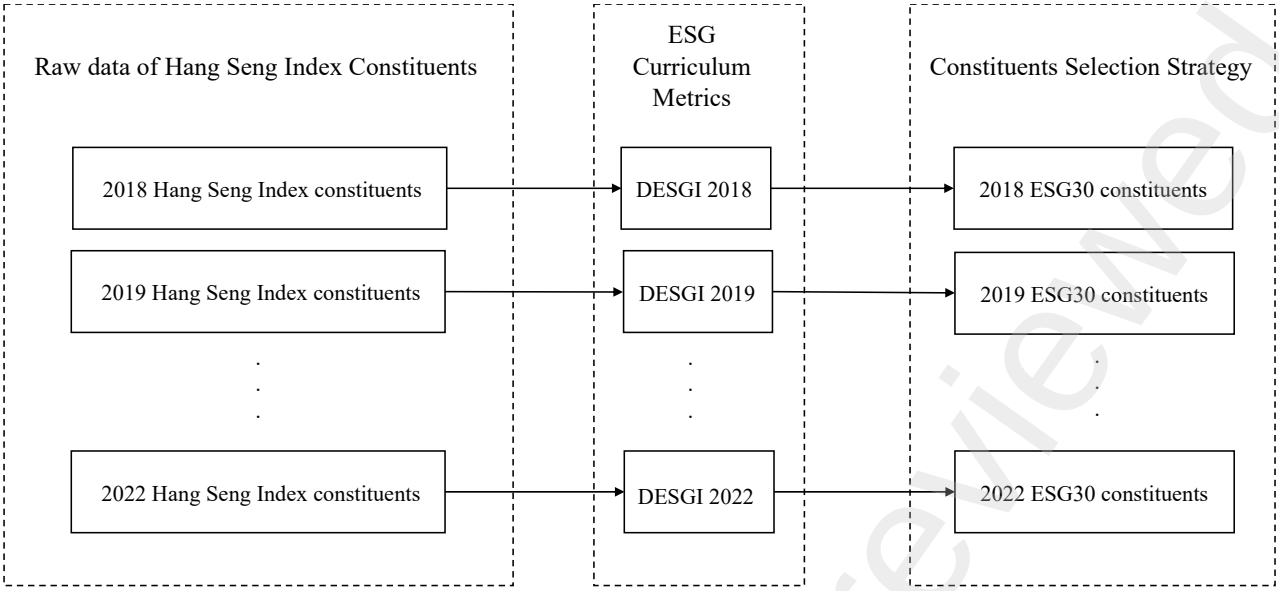

Figure 2. Process of screening constituent stocks

The DESGI score for each company is calculated through total GPA value and the summary of obtained course credits. A method of equal-weight allocation is adopted for the weighting of credits and GPAs. Subsequently, rankings for each year's constituents are determined based on the DESGI scores. From year 2019 to 2022, the top 28 companies are selected as the constituent for this study (where China Mobile and CITIC Limited have been included in advance). In 2022, Zijin Mining was newly added. As it is the only raw material industry representative in the Hang Seng Index, like China Mobile and CITIC Limited, was directly included in the index. Therefore, only the top 27 companies are screened out. Since the ESG report is usually updated once a year, this study updates the composition of constituent stocks at the beginning of each year from 2019 to 2023 according to the ranking of DESGI scores.

The stock screening results of year 2022 as an example are shown as Table 6. The result covers 30 stocks in 11 industries, of which the consumer discretionary accounts for the most, has 6 stocks; Information Technology, Consumer Staples and Energy industries account for 5 stocks, 4 stocks, and 4 stocks respectively, these four industries have 19 stocks, which accounting for 63.3% of the total.

3.3.2 Correlation Analysis with Existing ESG Assessment

In order to verify the robustness of the ESG performance assessed by the DESGI model, this section employs Spearman correlation coefficient to measure the correlation between existing ESG rating and the DESGI proposed in this paper. Spearman's correlation coefficient is selected based on the ranks of the variables rather than their original values, thus providing a meaningful measure of correlation even in cases of non-linear relationships. DESGI focuses on 80 listed companies selected from the Hang Seng Index, among which Bloomberg ESG rating has covered 55 listed companies, S&P Global has covered 50 listed companies, Refinitiv has covered 76 listed companies.

Therefore, the Spearman coefficient is calculated based on the mutual ESG scores. The Spearman correlation results are shown as Table 7.

In general, when the Spearman's coefficient approaches 1, it indicates a higher positive correlation between the two variables. When the value falls between 0.3 and 0.7, it suggests a moderate degree of correlation. From the Spearman correlation analysis, most ESG assessment results share a moderate degree of correlation since the Spearman coefficient value is larger than 0.4. It indicates that the mainstream ESG rating agencies share a good consistent level with DESGI assessment result. Among these, S&P500_Global exhibits the weakest correlation with other ESG assessment results. This could be attributed to the fact that S&P500_Global focuses on exposing the ESG risks of listed companies, employing a distinct ESG assessment framework and metrics compared to other ESG rating approaches.

Table 6. DESGI30 index constituent stocks in Year 2022

Industry	Constituent	DESGI Score
Utilities	ENN ENERGY	3.35
	CLP HOLDINGS	3.26
Consumer Discretionary	CHOW TAI FOOK	3.41
	SANDS CHINA LTD	3.40
	TECHTRONIC IND	3.36
	ANTA SPORTS	3.34
	GEELY AUTO	3.31
	SHENZHOU INTL	3.24
Information Technology	XIAOMI - W	3.40
	LENOVO GROUP	3.36
	NTES - S	3.25
	TENCENT	3.24
	JD - SW	3.23
Consumer Staples	NONGFU SPRING	3.32
	MENGNIU DAIRY	3.31
	BUD APAC	3.30
	WH GROUP	3.25
Industrials	XINYI SOLAR	3.33
	OOCL	3.18
Energy	SINOPEC CORP	3.28
	PETROCHINA	3.23
	CHINA SHENHUA	3.19
	CNOOC	3.17
Healthcare	HANSOH PHARMA	3.32
	ALI HEALTH	3.23
	WUXI BIO	3.20
Financials	HSBC HOLDINGS	3.33
Telecommunications	CHINA MOBILE	--
Materials	ZIJIN MINING	--
Conglomerates	CITIC	--

Table 7. Spearman correlation among the DESGI assessment and existing ESG assessment

	Refinitiv	Bloomberg	S&P500_Global	DESGI
Refinitiv	1.0000	0.4492	0.4095	0.4732
Bloomberg	--	1.0000	0.4481	0.4245
S&P500_Global	--	--	1.0000	0.3475
DESGI	--	--	--	1.0000

3.4 Index construction methods

This section describes the construction method of the DESGI30 index, which primarily involves incorporating smart beta factors. Despite variations in factor definitions in the market, they can generally be categorized into six groups: value, momentum, quality, dividend yield, volatility, and size. In this study, the focus will be on selecting the smart beta factors of size, dividend yield, volatility, and quality to construct the index. Subsequently, six different indexes will be constructed and subjected to comparative analysis.

It is worth noting that the Smart Beta investment strategy is typically reflected in two major steps of index construction: stock selection and weight allocation. Implementing either of these steps can be considered a Smart Beta strategy. Since this paper has already employs the DESGI model for stock selection in section 3.3, the strategies constructed in the subsequent sections will focus on changing the weight allocation strategies.

3.4.1 DESGI30 Equal-weighted Index

The selected 30 stocks in each year, as mentioned in Section 3.3, are subjected to an equal-weighting allocation for the portfolio composition. This approach entails assigning an equal weight to each constituent stock, which emphasizes equal treatment of all stocks, ensuring that companies with smaller market capitalizations wield the same level of influence in the portfolio as those with larger market capitalizations. Weight of each constituent is computed in (1).

$$w_i = \frac{1}{N} \tag{1}$$

where w_i represents the weight of the *i*-th constituent stock, *N* represents the total number of constituent stocks.

3.4.2 DESGI30 Net-Yield Weighted Index

The index derived from Section 3 stock selection is subjected to a return-based weighting scheme. In this strategy, the net yield of each constituent stock is employed as the reference to allocate weight. Stocks with higher net yield are granted greater influence in the index. This weighting method enhances the sensitivity of the index to the performance of high-return assets. Weight of each constituent is computed in (2).

$$w_i = \frac{R_i}{\sum_{j=1}^{N} R_j} \tag{2}$$

where w_i represents the weight of the *i*-th constituent stock, *N* denotes the total number of constituent stocks, and R_i stands for the net yield of the i-th constituent stock.

3.4.3 DESGI30 Volatility-weighted Index

The constituents derived from the stock selection in Section 3 is subjected to a volatility-based weighting scheme. In this strategy, the reciprocal of each constituent stock's historical volatility is employed as its respective weight. Stocks with higher volatility exhibit smaller reciprocals, resulting in lower weights. Volatility is assessed using the standard deviation of the constituent stock prices. Additionally, the index is rebalanced annually, incorporating new year's stock data into the historical dataset for standard deviation calculation, thereby determining the weights for the next period. This strategy leans towards investing in relatively stable stocks, aiming to achieve comparatively steady returns. Weight of each constituent is computed in (3).

$$w_i = \frac{\delta_i^{-1}}{\sum_{j=1}^{N} \delta_j^{-1}} \tag{3}$$

where w_i represents the weight of the *i*-th constituent stock, *N* represents the total number of constituent stocks, and δ_i represents the standard deviation of the stock prices of the constituent stocks.

3.4.4 DESGI30 Fundamentally-weighted Index

The fundamentally-weighted strategy allocating the weights of different investment portfolios based on fundamental factors from financial statements. This study specifically incorporates book value, revenue, cash flow, and dividends as fundamental factors, assigning them equal weights to form a comprehensive fundamental factor composite. Weight of each constituent is computed in (4).

$$w_i = \frac{F_i}{\sum_{j=1}^{N} F_j} \tag{4}$$

where w_i represents the weight of the *i*-th constituent stock, *N* represents the total number of constituent stocks, and F_i represents the comprehensive fundamental factor composite.

The comprehensive fundamental factor composite is computed in (5).

$$F_i = \frac{\frac{Equity_i}{\sum Equity} + \frac{CF_i}{\sum CF} + \frac{Revenue_i}{\sum Revenue} + \frac{Dividend_i}{\sum Dividend}}{4} \tag{5}$$

where $Equity_i$ represents book value and is measured using market capitalization; CF_i encompasses cash flows from operating activities, investing activities, and financing activities; $Revenue_i$ represents the total income obtained through various channels, including sales of products or provision of services, interest, and investments; $Dividend_i$ signifies the surplus distributed to shareholders by the company.

Given that the historical backtesting period of this stock selection model spans from 2018 to 2022, the weighting process aligns with the stock selection process. In other words, it commences from 2018 and allocates weights based on the financial statements of companies for that respective year. Furthermore, the index is rebalanced annually, incorporating data from the reports of the new financial year to calculate the weights

for the subsequent period. This strategy considers a comprehensive set of factors.

3.4.5 DESGI30 Market-Cap Weighted index

As one of the most common strategies in index construction, market-cap weighted indexes allocate weights based on the market capitalization of each constituent stock. Weight of each constituent is computed in (6).

$$w_i = \frac{M_i}{\sum_{j=1}^{N} M_j} \tag{6}$$

where w_i represents the weight of the *i*-th constituent stock, N denotes the number of constituent stocks, and M_i signifies the market capitalization of the *i*-th company. Market-cap weighted index is commonly used to gauge the overall performance of the stock market, i.e. the Hang Seng Index and the S&P 500 Index, both of which are market-cap weighted indexes. This strategy can reflect the influence of the largest companies in the market on the overall market performance. However, it may also lead to a situation where a small number of large companies dominate the index, potentially overlooking the performance of smaller companies within the index.

3.4.6 DESGI30 Index

Based on the stock selection outlined in Section 3, this strategy utilizes the DESGI model to derive DESGI scores for adjusting the weights of constituents. A higher DESGI score corresponds to a larger weight of the stock. However, due to the relatively small differences between DESGI scores, directly applying the calculation method of a yield weighted index would result in very small variations in weights among each stock. Therefore, referring to the weight balancing calculation method of the Hang Seng ESG Index[15], the process of weight balancing for the DESGI30 index is determined as follows:

i. To standardize the DESGI scores for each constituent stock, Z-scores are computed in (7).

$$\mathrm{Z} = (DESGIi - \mu)/\,\delta \tag{7}$$

where Z represents the Z-score, $\mathrm{DESGI_i}$ represents the DESGI score of each constituent stock, μ represents the average DESGI score of all constituent stocks, and δ represents the standard deviation of DESGI scores for all constituent stocks.

ii. To limit extreme Z-scores between -3 and 3, the following formula (8) is applied.

$$\mathrm{Z}' = max(min(Z,3), -3) \tag{8}$$

where Z' is the adjusted Z score.

iii. The tilt factor of each constituent stock is calculated in (9).

$$\mathrm{TF} = \begin{cases} 1 + \mathrm{Z}' & (\mathrm{Z}' >= 0) \\ 1/(1 + |\mathrm{Z}'|) & (\mathrm{Z}' < 0) \end{cases} \tag{9}$$

For negative Z-scores (corresponding to DESGI scores below the average), take the absolute value, add 1, and then take the reciprocal as the TF. For positive Z-scores, the TF will be greater than or equal to 0, indicating non-negative Z-scores

[15] HSI. For Managing the HSI ESG Index; and HSCEI ESG Index. https://www.hsi.com.hk/static/uploads/contents/zh_cn/dl_centre/methodologies/IM_hsiesgc.pdf

(corresponding to average or above-average ESG scores), and 1 is added to the TF. If, after tilting, the total weight of constituent stocks deviates from 100%, the following normalization step is used to adjust the tilt factor.

iv. Standardization is carried out with the purpose of adjusting the tilt factor to achieve a total weight of 100% for constituent stocks, while setting a maximum weight limit of 10% for each constituent stock. Therefore, a scaling factor 's' is introduced to adjust the weights of constituent stocks with DESGI scores below the average. The specific calculation formula is as follows in (10).

$$\mathrm{TF} = \begin{cases} \min(1 + \frac{Z'}{S}, 10\%) & (\mathrm{Z}' >= 0) \\ 1/(1 + |\mathrm{Z}'| * \mathrm{s}) & (\mathrm{Z}' < 0) \end{cases} \tag{10}$$

3.5 Measuring portfolio performance

In order to assess the performance of index under different strategies, this section proposes relevant indicators for evaluating the index performance, taking into account both risk and income aspects. The performance of an index is influenced by its inherent characteristics and is accompanied by a certain level of risk. This section employs risk assessment indicators such as annualized volatility and maximum drawdown to measure the risk level of the investment strategy. Furthermore, to evaluate the profit potential of the investment strategy, it is typically necessary to consider its earnings. Therefore, this study utilizes three indicators, annual return rate, Sharpe ratio, and Sortino Ratio, to assess the performance of the investment strategy.

3.5.1 Risk assessment indicators

a. Annualized volatility

Annualized volatility is a measure of the price volatility of a financial asset or portfolio over a period of time, usually expressed in years. It is an important indicator of investment risk and could help investors understand the extent of price volatility that an asset or portfolio may experience. The annualized volatility is computed in (11).

$$\sigma_p = std(R_t) \times \sqrt{12} \tag{11}$$

where R_t is the daily return sequence of the strategy, and σ_p is the annualized volatility of the strategy.

b. Maximum Drawdown

Maximum Drawdown is an indicator used to indicate the maximum loss of a portfolio or asset from peak to trough within a specific period. The maximum drawdown rate is used to help investors understand the worst-case scenario that their investment may experience over a certain period of time. The maximum drawdown is computed in (12).

$$Maximum\ Drawdown = \frac{Max(P_x - P_y)}{P_x} \tag{12}$$

where P_x is the net value of the strategy on the xth day, and P_y is the net value of the strategy on a later day of P_x.

3.5.2 Income evaluation indicators

a. Annualized rate of return

The Annualized rate of return measures the total return earned by a strategy over a specific period of time compared to the initial investment amount. The Annualized rate of return is computed in (13).

$$R_P = [(1+R)^{\frac{12}{n}} - 1] \times 100\% \tag{13}$$

where R is the rate of return of the strategy in the entire investment range, and n is the number of days the strategy is held.

b. Sharpe ratio

The Sharpe ratio measures the additional return earned by an investment strategy for each unit of risk assumed (Sharpe, 1964). The higher the Sharpe ratio, the higher the return a strategy earns per unit of risk, which is considered a risk-adjusted return indicator. The Sharpe ratio is computed in (14).

$$Sharp\ Ratio = \frac{R_p - R_f}{\sigma_p} \tag{14}$$

where R_p is the annualized rate of return of investment, R_f is the risk-free interest rate in the market, and σ_p is the annualized volatility of the investment strategy.

c. Sortino ratio

The Sortino ratio is a risk-adjusted indicator that focuses on adverse movements (i.e. situations where returns are negative). A higher Sortino ratio indicates that a strategy performs better during depressed market conditions; a lower Sortino ratio may indicate that the strategy requires better risk management. The Sortino ratio is computed in (15).

$$\text{Sortino } Ratio = \frac{\bar{R}p - R_f}{D} \tag{15}$$

where $\bar{R}p$ represents the average return of the strategy, R_f is the risk-free interest rate in the market, and D is the downside standard deviation of the investment strategy.

4. Empirical results

4.1 Performance of six DESGI30 Indexes

This section conducts a historical backtesting analysis of the above smart beta strategies. Taking the Hang Seng Index as the benchmark index, this study conducted a backtest on the historical performance of six DESGI30 indexes constructed based on different smart beta strategies outlined in Section 3.4. The backtesting period spans from January 2019 to August 2023. The specific performance is compared and analyzed through net value curves and performance indicators presented in Section 3.5.

From the historical backtesting results shown in Figure 3, the cumulative net values of the six strategies are significantly superior to the Hang Seng Index during the same period, which demonstrates that the DESGI model has the ability to screen out stocks with high-rated ESG performance. Among these six indexes, the two most outstanding indexes are the DESGI30 Net-Yield Weighted index and the DESGI30 index. It can be observed that the DESGI30 Net-Yield Weighted index had the highest cumulative net value in June 2021, surpassing other investment strategies at the same time point. On

the other hand, the DESGI30 index had the highest cumulative net value in October 2022, when the cumulative net values of all strategies retreated to their lowest value in the whole time interval.

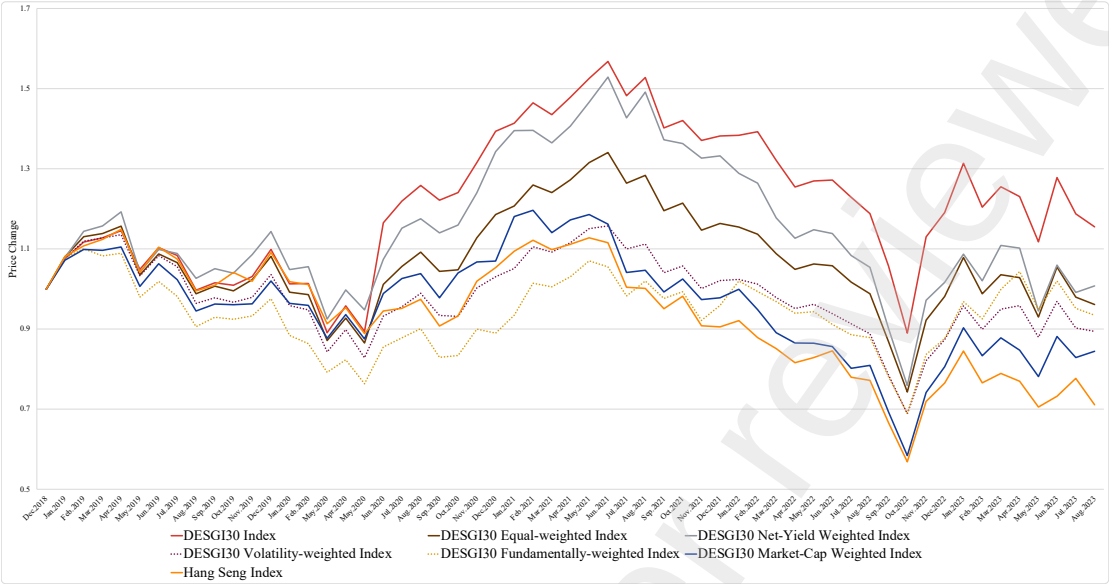

Figure 3. Net Value Curve of six smart beta strategy Indexes versus Hang Seng Index

Table 8. Investment strategy performance

	Income evaluation indicators			**Risk assessment indicators**	
Name of Strategy	**Annualized rate of return**	**Sharpe ratio**	**Sortino Ratio**	**Annualized volatility**	**Maximum Drawdown**
DESGI30 Index	3.31%	6.35%	382.52%	27.76%	43.26%
DESGI30 Equal-weighted Index	-0.83%	--	59.85%	24.54%	44.60%
DESGI30 Net-Yield Weighted Index	0.16%	--	160.07%	26.41%	50.37%
DESGI30 Volatility-weighted Index	-2.26%	--	-71.17%	21.55%	40.50%
DESGI30 Fundamentally-weighted Index	-1.40%	--	-128.35%	22.36%	37.30%
DESGI 30 Market-Cap Weighted Index	-3.33%	--	-72.41%	25.30%	51.17%
Hang Seng Index	-6.19%	--	-91.88%	23.94%	50.55%

Due to the underperformance and significant drawdowns of the Hang Seng Index in recent years, only the DESGI30 index and the DESGI30 Net-Yield Weighted index achieve positive annualized returns, as shown in Table 8. The other four strategies, while all showing negative annualized returns, have absolute values of less than 4%, which is better than the Hang Seng Index. When the Sharpe Ratio is negative, the indicator loses its reference value, and therefore, no further analysis will be conducted on this indicator. From the perspective of Sortino Ratio (with a risk-free rate of 3%), three of the indexes have a Sortino Ratio greater than 0. Except for the DESGI30 fundamentally-weighted index, which has a lower Sortino Ratio than the Hang Seng

Index, the remaining five indexes all surpass the benchmark Index. Among them, the DESI30 index achieves the highest Sortino Ratio, reaching 382.52%, indicating that this investment strategy could yielded better returns under relatively lower risk.

Additionally, considering the risk assessment indicators in the table, investment strategies based on the DESGI model effectively reduce the maximum drawdown. The DESGI30 index and the DESGI30 Net-Yield Weighted index, being the only two strategies with positive annualized returns, have reduced their maximum drawdowns by 7.29% and 0.18% respectively compared to the Hang Seng Index. The DESGI30 fundamentally-weighted index also achieve a reduction of over 10% in maximum drawdown. However, the impact on annualized volatility is not significant, with only slight decreases in the annualized volatility of the DESGI30 volatility-weighted index and the DESGI30 fundamentally-weighted index compared to the Hang Seng Index. It is also worth noting that the overall performance of the market-cap weighted index is slightly inferior. The maximum drawdown rate is even higher than that of the Hang Seng Index. This phenomenon could be explained by the imbalance of weight distribution. For example, from the index weight allocation of constituent stocks in year 2021, the combined weight of Tencent (44.16%) and HSBC (6.95%) alone exceeds 50%, accounting for more than half of the weight. This creates a situation where the performance of the entire index is dominated by the performance of a few individual companies.

In general, after thorough validation of six strategies, combining the constituents screening by the ESG assessment using the DESGI model with Smart Beta strategies indeed improves the performance and drawdown characteristics of the indexes.

4.2 Index rebalancing

In the previous analysis, the DESGI model played a role solely in constituent screening. In the process of weight allocation, only the DESGI30 index used ESG assessment results as the reference of weight allocation, and from section 4.1, the results provide a strong support that by integrating ESG assessment in the process of weight allocation could achieve a better performance than traditional Smart Beta factor strategies. To enhance the robustness of the conclusion and verify if integrating ESG assessment in weight allocation process could improve the performance of existing strategies, this section rebalanced the DESGI30 Net-Yield Weighted index, the DESGI30 volatility-weighted index, the DESGI30 fundamental-weighted index, and the DESGI30 Market-Cap weighted index based on DESGI scores. The subsequent sections present a detailed analysis process, comparing the net asset value curves of the rebalanced strategy and performance indicators with the original strategy.

Index rebalancing is the process of readjusting the weights of individual components based on their respective ESG assessment, following the determination of the five investment portfolio weights outlined in Section 3.4. The primary reference utilized in this process is the DESGI scores. Index rebalancing augments the investment weights of companies exhibiting superior ESG performance through a balancing mechanism. The adjusted weight of each constituent is computed in (16).

$$w_i = \frac{w_{i1} * w_{i2}}{\sum_{i=1}^{N} w_{i1} * w_{i2}} \quad (16)$$

where w_i is the weight of the i-th constituent stock, N is the number of constituent stocks, w_{i1} is the weight of the i-th component stock obtained based on the DESGI score, w_{i2} is the weight of the i-th component stock obtained by the original Smart Beta strategy, and the final weight is the product of the two weights.

After applying index rebalancing to the DESGI30 Net-Yield Weighted index, DESGI30 volatility-weighted index, DESGI30 fundamental-weighted index, and DESGI30 Market-Cap Weighted index, utilizing the Hang Seng Index as a benchmark, the net asset value curves for the four rebalanced strategies, along with the DESGI30 index, are jointly compared.

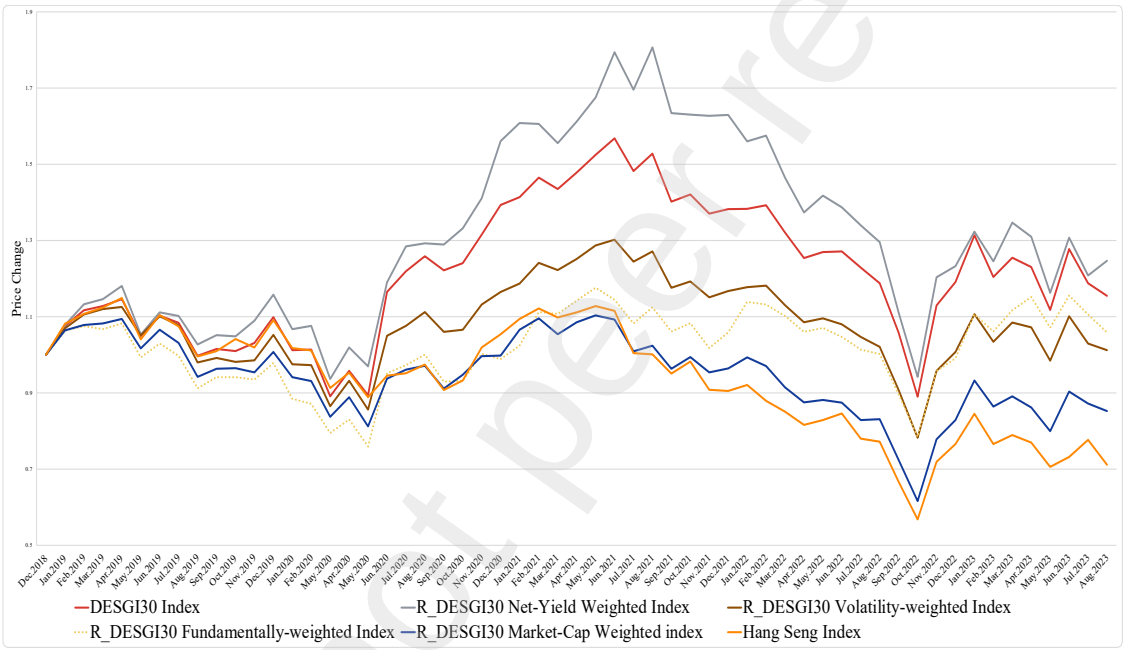

Figure 4. Performance of NAV curves of rebalanced Indexes versus Hang Seng Index

Table 9. Rebalanced Investment strategy performance

Name of Strategy	Annualized volatility	Maximum Drawdown
DESGI30 Index	27.76%	43.25%
R_DESGI30 Net-Yield Weighted Index	27.73%	48.15%
R_DESGI30 Volatility-weighted Index	23.91%	39.93%
R_DESGI30 Fundamentally-weighted Index	24.28%	35.39%
R_DESGI 30 Market-Cap Weighted Index	24.34%	44.14%
Hang Seng Index	23.94%	50.55%

It can be found that all five DESGI30 indexes outperform the Hang Seng Index

significantly. After the weight adjustment by ESG assessment, the annualized volatility and maximum drawdown rate of each index have been improved. In particular, the DESGI 30 Market-Cap Weighted Index has changed from a maximum drawdown rate (51.17%) greater than the Hang Seng Index before rebalancing to a current state where the maximum drawdown rate (44.14%) is less than the Hang Seng Index.

To further analyze the impact of using ESG performance for rebalancing on ESG indexes, this study compares the indexes before and after rebalancing respectively. The results are shown as Figure 5 and Table 10.

For the net-yield weighted index, it is evident that the rebalanced index diverges from the original index after April 2020. This enhancement leads to a 27.73% increase in the maximum net asset value and a 2.22% reduction in the maximum drawdown rate. The annualized return of the rebalanced index also achieves an improvement of 5.14%, while the annualized volatility rises from 26.4% to 27.7%. During the same period, the maximum cumulative net asset value difference reaches 31.57%, with the minimum difference being only -1.20%. Over the 56-month historical backtesting period, the rebalanced DESGI30 Net-Yield Weighted index outperformed its pre-balanced state in 52 months (92.9%). Therefore, the performance of the rebalanced DESGI30 Net-Yield Weighted Index significantly surpasses its pre-balanced state. The Net-Yield Weighted index concentrates on assets with higher potential returns, which indeed yields higher profits in prosperous market conditions but also exposes investors to greater risks. However, by showing that the performance indicators of the rebalanced DESGI30 Net-Yield Weighted Index have all increased except the annualized volatility, this study further affirms the conclusion that incorporating ESG assessment into investment strategies enhances their ability to withstand downturns and risks.

For volatility-weighted index, it can be clearly seen from Figure 5 and Table 10 that the rebalanced index diverges from the original index from May 2020. This enhancement leads to a 14.49% increase in the maximum net asset value in June 2021, and a 0.56% reduction in the maximum drawdown rate. The annualized return of the rebalanced index increases by 2.53%, while the annualized volatility rises from 21.55% to 23.91%. During the same period, the maximum cumulative net asset value difference reaches 16.9%, with the minimum difference being only -1.3%. Over the 56-month historical backtesting period, the rebalanced DESGI30 volatility-weighted index outperforms its pre-balanced state in 52 months (92.9%), which shows a great improvement over its pre-rebalanced state in general.

For the fundamentally-weighted index, it is evident that the rebalanced index diverges from the original index from June 2020. The minimum net asset value also decreased by 6.97%. The annualized return of the rebalanced index increases by 2.67%. The annualized volatility rises from 22.3% to 24.3%. During the same period, the maximum cumulative net asset value difference reaches 15.50%, with the minimum difference being only -2.6%, which further illustrates that rebalanced index has improved its cumulative net asset value. Over the 56-month historical backtesting period, the rebalanced DESGI30 volatility-weighted index outperforms its pre-balanced state in 51 months (91%). Overall, the performance of the rebalanced DESGI30 Fundamentally-weighted index shows a significant improvement over its

pre-balanced state.

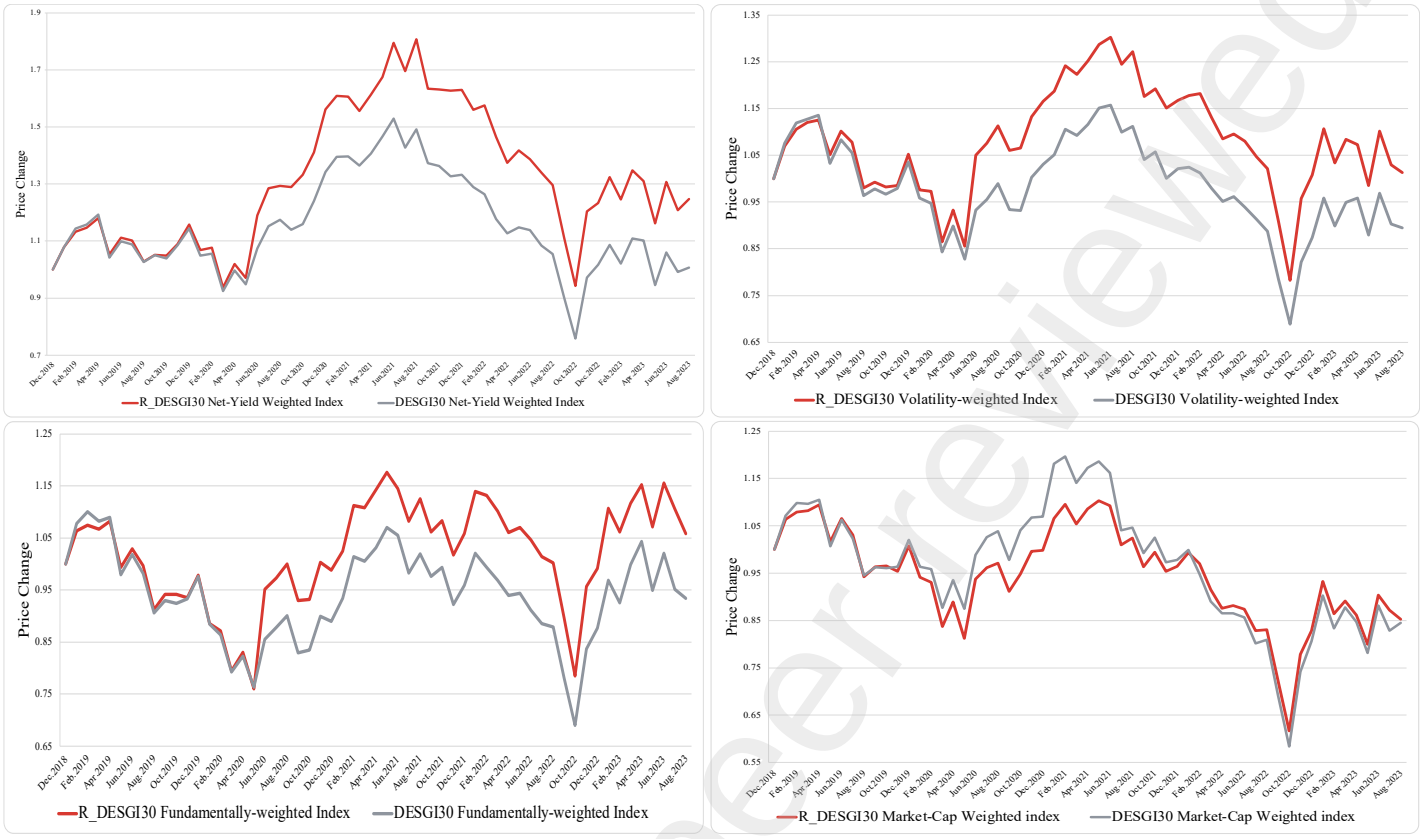

Figure 5. NAV curves between the the rebalanced index and original index

Table 10 Comparison between the rebalanced index and original index

	R_DESGI30 Net-Yield Weighted Index	DESGI30 Net-Yield Weighted Index	R_DESGI30 Volatility-weighted Index	DESGI30 Volatility-weighted Index	R_DESGI30 Fundamentally-weighted Index	DESGI30 Fundamentally-weighted Index	R_DESGI30 Market-Cap Weighted Index	DESGI30 Market-Cap Weighted Index
Annualized rate of return	5.30%	0.16%	0.27%	-2.26%	1.26%	-1.40%	-3.17%	-3.33%
Annualized volatility	27.73%	26.41%	23.91%	21.55%	24.28%	22.36%	24.35%	25.30%
Peak	80.69%	52.87%	30.19%	15.70%	17.58%	10.04%	10.33%	19.66%
Trough	-6.33%	-24.12%	-21.80%	-31.15%	-24.04%	-31.00%	-38.39%	-41.57%
Maximum Drawdown	48.16%	50.37%	39.94%	40.50%	35.40%	37.30%	44.16%	51.17%
Maximum net worth gaps	31.57%	1.20%	16.93%	1.32%	15.47%	2.55%	4.32%	11.49%
Number of winning months	52	4	52	4	51	5	24	32
Number of winning indicators	6	1	6	1	6	1	4	3

For the market-cap weighted index, rebalanced index showed inferior performance compared to the original state before February 2022. However, it demonstrated a better performance after hitting the bottom, accompanied by a 3.2% reduction in the minimum

net asset value. The rebalanced index displayed a similar performance to the original's in the annualized return, with slight advantages in maximum net asset value and annualized volatility. Over the 56-month historical backtesting period, the rebalanced DESGI30 Market-Cap Weighted index outperformed the unbalanced index in 24 months (42.9%). In conclusion, based on the final comparison, the rebalanced DESGI30 Market-Cap Weighted index exhibited slightly superior performance compared to the pre-balanced state, demonstrating the ability of the ESG factor to reduce volatility and mitigate risk.

From the above analysis results, it can be observed that integrating ESG performance into smart beta strategies indeed proves effective in enhancing stock index performance, achieving the objectives of increasing annual returns or reducing risk. However, given the construction of ten indexes in this study, investors without specific styles or investment preferences may still be perplexed about how to select the most suitable index. Among all the indexes constructed in this study, both the DESGI30 index and the rebalanced DESGI30 Net-Yield Weighted index exhibit notable superiority over the other types of indexes. Therefore, the NAV curve and performance comparison for these two strategies are illustrated in the Figure 6 and Table 11. It is observed that the rebalanced DESGI30 Net-Yield Weighted index outperforms the DESGI30 index. In fact, the mostly numerical values of each indicator for the rebalanced DESGI30 Net-Yield Weighted Index show an absolute advantage. However, the DESGI30 Index has a lower maximum drawdown rate. This observation could demonstrate that the rebalanced DESGI30 Net-Yield Weighted Index shows superior performance during a favorable market environment, exhibiting a more vigorous upward trend and achieving higher absolute returns. However, in the face of unforeseen events such as a pandemic, it is distinctly noticeable that the DESGI30 index experiences a smaller decline in the downside range with a lower maximum drawdown. This indicates a stronger risk resilience in the DESGI30 index.

4.3 Correlation Analysis with Existing ESG Indexes

This section employs the Hang Seng ESG50 index for comparative analysis. The Hang Seng ESG50 index, developed by Hang Seng Indexes Company Limited, is an Environmental, Social, and Governance (ESG) index designed to measure the performance of 50 companies listed on the Hong Kong Stock Exchange in the ESG domain. Currently, the earliest available data for this index dates to the end of July 2020. Therefore, this study select the period from August 2020 to August 2023 as the historical backtesting period. The NAV curves and performance comparisons for the Hang Seng ESG50 index and the DESGI30 index are illustrated in Figure 7 and Table 12.

From the figure, it clearly illustrates that the two indexes have similar trends with each other. In the initial stages of backtesting period, the Hang Seng ESG50 index slightly outperforms the DESGI30 index. However, starting from May 2021, the trends of the two indexes gradually converge. After June 2021, the DESGI30 index began to outperform the Hang Seng ESG50 index and exhibited a significant advantage for all the remaining months. Overall, the DESGI30 index exhibits a relatively consistent trend with the Hang Seng ESG50 index. The comparative results of performance

indicators from Table 10 indicate that the DESGI30 index had a better performance than the Hang Seng ESGI30 index. Not only the winning months account for 77.7% of the three-year backtesting period (18 months), but also had three indicators that performs better. These comparative results reveal that the DESGI30 index closely aligns with the Hang Seng ESGI30 index developed by Hang Seng Indexes Company Limited, which suggests that the index construct in this study exhibits a certain degree of correlation with existing ESG indexes in the market.

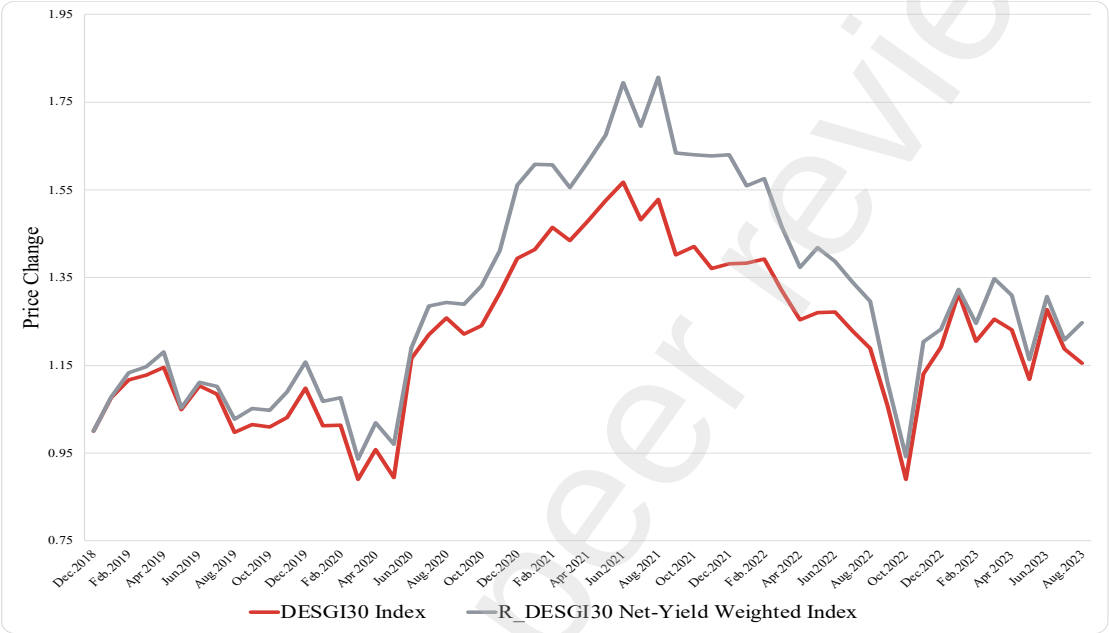

Figure 6. NAV curves of the DESGI30 index and the rebalanced DESGI30 Net-Yield Weighted index

Table 11 Comparison between the DESGI30 index and the rebalanced DESGI30 Net-Yield Weighted index

	DESGI30 Index	R_DESGI30 Net-Yield Weighted Index
Annualized rate of return	3.32%	5.30%
Annualized volatility	27.76%	27.73%
Peak	56.81%	80.67%
Trough	-11.01%	-6.32%
Maximum Drawdown	43.25%	48.15%
Maximum net worth gaps	-0.20%	27.88%
Number of winning months	0	56
Number of winning indicators	1	6

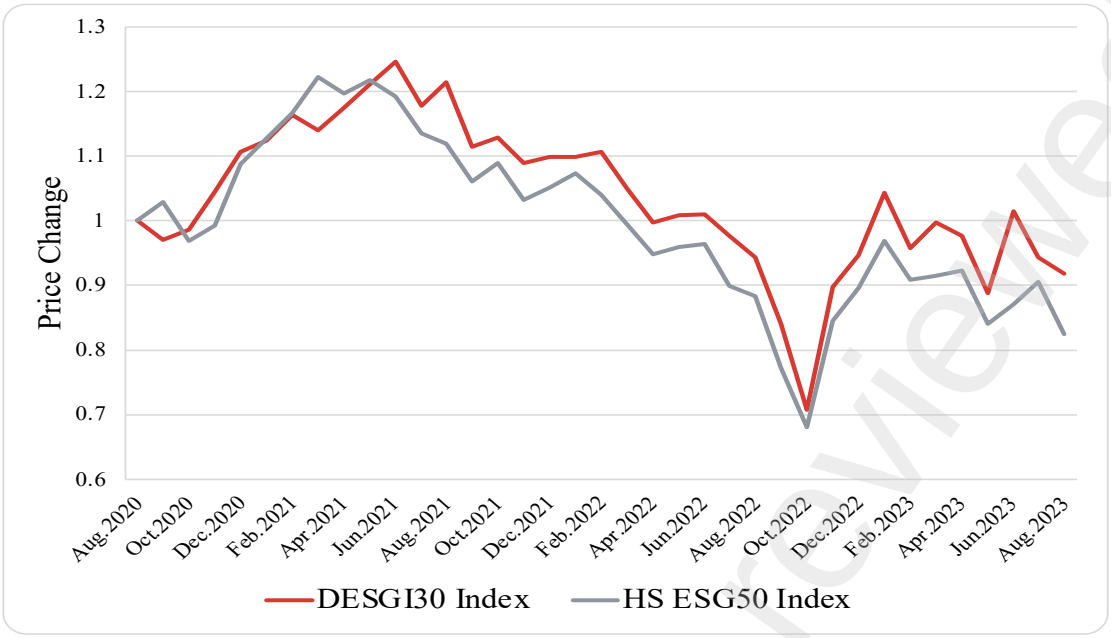

Figure 7. NAV curves of the DESGI30 index and the Hang Seng ESG50 index

Table 12. Comparison between the DESGI30 index and HS ESG50 index

	DESGI30 Index	HS ESG50 index
Annualized rate of return	-8.21%	-17.51%
Annualized volatility	26.18%	23.43%
Peak	124.61%	122.33%
Trough	70.72%	68.11%
Maximum Drawdown	43.25%	44.32%
Maximum net worth gaps	14.50%	8.29%
Number of winning months	14	4
Number of winning indicators	3	3

5. Conclusion

With the increasing attention to sustainable investment, investors are expecting to channel their funds to companies that act responsibly and sustainably. In order to effectively incorporate ESG assessments into the decision-making process for investments in China, this study firstly screened out the top 30 companies with high ESG ratings by introducing a novel Dual ESG Index framework. The DESGI model is not only considers the breadth and depth of a company's sustainability capabilities (reflected in credits and GPA), but also extends the scope of evaluation. This enables companies of varying sizes in different industries to achieve more precise differentiation through the DESGI framework. Next, this study assigned appropriate weights to each constituent according to six smart beta strategies, integrating the ESG assessment into smart beta strategies from a weight allocation perspective. Then, this study constructed ten ESG indexes, which are DESGI30 Index, DESGI30 Equal-weighted Index, DESGI30 Net-Yield Weighted Index, DESGI30 Volatility-weighted Index, DESGI30 Fundamentally-weighted Index, DESGI 30 Market-Cap Weighted

Index, and four rebalancing indexes based on the latter four indexes. Furthermore, to validate the feasibility of the ESG indexes, this study conducted a backtest on the historical performance of ten ESG indexes constructed, taking the Hang Seng index as the benchmark and using the real-life ESG data and stock data during past five years. The study also made the correlation analysis with existing ESG indexes to further prove the reliability of the ESG indexes constructed in this study.

The contributions of this study are summarized as follows: (1) The introduced Dual ESG Index framework brings the advantages such as scalability and flexibility into ESG assessment process, which provides a more suitable framework for evaluating the ESG performances of companies in the Chinese market. (2) By applying ESG scores in both stock screening and weight allocation processes, this study integrates ESG assessment into six smart beta strategies, provides a reliable reference for the academic on the integration of ESG and smart beta strategies and enriches the literature about the determinants of ESG performance by further proving the importance of ESG factors in the investment process. (3) This study constructed ten ESG indexes with different weight allocating strategies based on the Hang Seng Index, providing Chinese investors interested in ESG investing with region-specific and feasible investment tools and enabling investors of different styles can access suitable ways to invest in green. (4) By using the real-life ESG data and stock data during the past five years to backtest the performance of ten ESG indexes constructed, this study obverses that there is a significant enhancement in index performance. Especially, the Net-Yield Weighted index and the DESGI30 index showed great performance among ten indexes, where the former achieved higher returns in prosperous market conditions, and the latter demonstrated stronger resilience during market downturns. These findings revealing the possibility of focusing on good ESG performance while achieving good benefits, suggest that fund managers can increase the weight of high ESG-rated stocks in the process of fund management to increase stability and reduce risk under different market conditions. At the same time, this study demonstrates the different results brought by six different weight allocation methods through empirical research, providing practical and reliable insight for fund managers to select suitable weight allocation methods.

Future research could be conducted in the direction of two processes: Companies screen out and smart beta strategies application. (1) In the process of companies screen out, this paper mainly focuses on the GPA calculation of DESGI model. There has been no optimization in the setting of course credits. The credit of each course is not differentiated, that is, each course has an equal weight. Subsequent research can continue to draw parallels with the academic credit system, assessing the evaluation complexity, implementation difficulty, and the level of importance of each specific course to the industry. This could render the entire DESGI system more comprehensive and better suited for application in real ESG assessment scenarios. Secondly, the associated risks related to ESG are not considered. However, the exposure of risk issues can easily impact investors' judgments on the company's ESG assessment, thereby influencing the overall value of the company. Subsequent research could consider incorporating risk factors into the DESGI system, making the entire assessment system more comprehensive and robust. (2) In the process of smart beta strategies application,

this paper conducts the empirical research on ten investment strategies. However, the selected Smart-Beta strategies are not diverse enough, which only consist of six fundamental investment strategies. This has also led to a situation where, when comparing the DESGI30 index and the DESGI30 Net-Yield Weighted index, the two strategies exhibit significant similarities. There is an occurrence of higher returns being associated with higher drawdowns, and lower returns being associated with lower drawdowns, which makes it difficult to discern superiority or inferiority. Therefore, given that the market continues to introduce new Smart Beta strategies and the DESGI model can indeed easily and efficiently integrate with Smart Beta strategies, future research can enhance the reliability and robustness of research conclusions by incorporating newly introduced Smart-Beta strategies.

Reference

Serafeim, G., & Yoon, A. (2022). Stock price reactions to ESG News: The role of ESG ratings and disagreement. Review of Accounting Studies, 28(3), 1500–1530. https://doi.org/10.1007/s11142-022-09675-3

Filbeck, A., Filbeck, G., & Zhao, X. (2019). Performance assessment of firms following Sustainalytics ESG principles. *The Journal of Investing*, *28*(2), 7–20. https://doi.org/10.3905/joi.2019.28.2.007

Tan, Y.-M., Szulczyk, K., & Sii, Y.-H. (2023). Performance of ESG-Integrated Smart Beta Strategies in Asia-Pacific Stock Markets. Research in International Business and Finance, 102008. https://doi.org/10.1016/j.ribaf.2023.10200

Dimson, E., Marsh, P., & Staunton, M. (2017). Factor-based investing: the long-term evidence. The Journal of Portfolio Management, 43(5), 15–37. https://doi.org/10.3905/jpm.2017.43.5.015

Kahn, R. N., & Lemmon, M. (2015). Smart beta: the owner's manual. The Journal of Portfolio Management, 41(2), 76–83. https://doi.org/10.3905/jpm.2015.41.2.076

Giese, G., Lee, L.-E., Melas, D., Nagy, Z., & Nishikawa, L. (2019). Foundations of ESG investing: how ESG affects equity valuation, risk, and performance. The Journal of Portfolio Management, 45(5), 69–83. https://doi.org/10.3905/jpm.2019.45.5.069

Park, S. R., & Oh, K.-S. (2022). Integration of ESG information into individual investors' corporate investment decisions: Utilizing the UTAUT framework. Frontiers in Psychology, 13. https://doi.org/10.3389/fpsyg.2022.899480

Dai, L., Song, C., You, Y., & Zhang, W. (2022). Do sovereign wealth funds value ESG engagement? evidence from target firm's CSR performance. Finance Research Letters, 50, 103226. https://doi.org/10.1016/j.frl.2022.103226

Kong, N., Bao, Y., Sun, Y., & Wang, Y. (2023). Corporations' ESG for Sustainable Investment in China: The moderating role of regional marketization. Sustainability, 15(4), 2905. https://doi.org/10.3390/su15042905

Wang, W., Yu, Y., & Li, X. (2022). ESG performance, Auditing Quality, and investment efficiency: Empirical evidence from China. Frontiers in Psychology, 13. https://doi.org/10.3389/fpsyg.2022.948674

Broadstock, D. C., Chan, K., Cheng, L. T. W., & Wang, X. (2021). The role of ESG performance during times of financial crisis: Evidence from covid-19 in China. Finance Research Letters, 38, 101716. https://doi.org/10.1016/j.frl.2020.101716

Li, X., Xu, F., & Jing, K. (2022). Robust enhanced indexation with ESG: An empirical study in the chinese stock market. Economic Modelling, 107, 105711. https://doi.org/10.1016/j.econmod.2021.105711

Davoodi, S., Fereydooni, A., & Rastegar, M. A. (2024a). Can portfolio construction considering ESG still Gain High Profits? Research in International Business and Finance, 67, 102126. https://doi.org/10.1016/j.ribaf.2023.102126

Halbritter, G., Dorfleitner, G., 2015. The wages of social responsibility - where are they? A critical review of ESG investing. Rev. Financ. Econ. 26, 25–35. https://doi. org/10.1016/j.rfe.2015.03.004.

Humphrey, J. E., Lee, D. D., & Shen, Y. (2012). Does it cost to be sustainable? Journal

of Corporate Finance, 18(3), 626–639. https://doi.org/10.1016/j.jcorpfin.2012.03.002

HARTZMARK, S. M., & SUSSMAN, A. B. (2019). Do investors value sustainability? A natural experiment examining ranking and fund flows. The Journal of Finance, 74(6), 2789–2837. https://doi.org/10.1111/jofi.12841

Renneboog, L., Ter Horst, J., & Zhang, C. (2008). Socially responsible investments: Institutional aspects, performance, and investor behavior. Journal of Banking & Finance, 32(9), 1723–1742. https://doi.org/10.1016/j.jbankfin.2007.12.039

Pedersen, L. H., Fitzgibbons, S., & Pomorski, L. (2021). Responsible investing: The ESG-efficient frontier. Journal of Financial Economics, 142(2), 572–597. https://doi.org/10.1016/j.jfineco.2020.11.001

Sharpe, W. F. (1964). Capital asset prices: A theory of market equilibrium under conditions of risk. The Journal of Finance, 19(3), 425. https://doi.org/10.2307/2977928

Kahn, R. N., & Lemmon, M. (2016). The Asset Manager's Dilemma: How Smart Beta Is Disrupting the Investment Management Industry. Financial Analysts Journal, 72(1), 15–20. https://doi.org/10.2469/faj.v72.n1.1

Bender, J., Hammond, P. B., & Mok, W. (2014). Can Alpha Be Captured by Risk Premia? The Journal of Portfolio Management, 40(2), 18–29. https://doi.org/10.3905/jpm.2014.40.2.018

Constantinides, G. M., & Duffie, D. (1996). Asset Pricing with Heterogeneous Consumers. Journal of Political Economy, 104(2), 219–240. https://doi.org/10.1086/262023

Lo, K. Y., & Kwan, C. L. (2017). The Effect of Environmental, Social, Governance and Sustainability Initiatives on Stock Value - Examining Market Response to Initiatives Undertaken by Listed Companies. Corporate Social Responsibility and Environmental Management, 24(6), 606–619. https://doi.org/10.1002/csr.1431

Xie, J., Nozawa, W., Yagi, M., Fujii, H., & Managi, S. (2018). Do environmental, social, and governance activities improve corporate financial performance? Business Strategy and the Environment, 28(2), 286–300. https://doi.org/10.1002/bse.2224

Stempler, B. (2021). ESG investing: The use of ESG ratings in a smart beta strategy. Financial and Economic Review, 20(2), 91–116. https://doi.org/10.33893/fer.20.2.91116

Giese, G., Ossen, A., & Bacon, S. (2016). ESG as a performance factor for smart beta indexes. The Journal of Index Investing. https://doi.org/10.3905/jii.2016.2016.1.046

Kahn, R. N., & Lemmon, M. (2016b). The Asset Manager's Dilemma: How Smart Beta Is Disrupting the Investment Management Industry. Financial Analysts Journal, 72(1), 15–20. https://doi.org/10.2469/faj.v72.n1.1

Zhou, L., Tokos, H., Krajnc, D., & Yang, Y. (2012). Sustainability Performance Evaluation in industry by Composite Sustainability index. Clean Technologies and Environmental Policy, 14(5), 789–803. doi:10.1007/s10098-012-0454-9

Sokolov, A., Caverly, K., Mostovoy, J., Fahoum, T., & Seco, L. (2021). Weak supervision and black-Litterman for automated ESG portfolio construction. The Journal of Financial Data Science, 3(3), 129–138. doi:10.3905/jfds.2021.1.070

Berg, F., Kölbel, J. F., & Rigobon, R. (2022). Aggregate confusion: The divergence of ESG Ratings. Review of Finance, 26(6), 1315–1344. https://doi.org/10.1093/rof/rfac033

Christensen, D. M., Serafeim, G., & Sikochi, A. (2021). Why is corporate virtue in the eye of the beholder? the case of ESG Ratings. The Accounting Review, 97(1), 147–175. https://doi.org/10.2308/tar-2019-0506

Hasan, M., Parvez, M., 2015. Choice-Based Credit System in India: Pros and Cons. Journal of Education Practice 6, 30-33.