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The impact of ESG rating on the asymmetrical volatility-return relationship: early evidence from a weight-tilted Hang Seng Index

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Abstract

This paper examines the volatility-return relationship of a market index that incorporates the ESG ratings of the constituent stocks. The study examines the return performance and resilience to the market volatility of the recently introduced ESG weight-tilted Hang Seng Index (HSIESG) compared to its parent Hang Seng Index (HSI). The ESG-infused index has a higher return and lower return volatility than the parent index, although the differences are statistically and economically insignificant, a result consistent with the high correlation between the two index returns. Most importantly, the asymmetrical volatility response of the ESG-infused index is significantly less than that of the parent index which led to a substantially higher holding period return of HSIESG than that of HSI. This result supports the proposition that the stocks with high ESG ratings are less susceptible to trading pressures triggered by volatility-induced turnovers. The paper contributes to the literature by providing significant incremental information on the emerging market for ESG-related equity products in Hong Kong.

Keywords: ESG impact investing, index investing, ESG tilted index

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The impact of ESG rating on the asymmetrical volatility-return relationship: early evidence from a weight-tilted Hang Seng Index

1. Introduction

The Environmental, Social/Sustainable, and Governance (ESG) rating and performance of a company affect its market value (Ward and Wu, 2019). On the supply side, a company may obtain government subsidies and/or reduction of levies by improving the firm's ESG scores; whilst on the demand side, stocks with high ESG performance attract ESG-conscious individuals and norm-constrained institutional investors. Moreover, investors whose focus is on risk-adjusted returns can further fuel the demand for stocks with high ESG ratings should the scores are priced in the market. All the above factors combine to produce a positive feedback loop which in effect can create a win-win situation for the companies with high ESG ratings, ESG advocates, profit-oriented agents, and ESG norms constrained or unconstrained institutional investors. Consequently, firms with high ESG ratings have a lower cost of equity capital and a higher valuation than those at the other end of the measure. The existence of the ESG premium in firm values can propel both financial and real economic activities to align economic goals with social welfare objectives.

In view of these conjectures, we postulate that firms with high ESG ratings are more resilient to market volatility than those with low ratings.[1] Particularly, the preference for high ESG firms makes them less susceptible to selling pressure in stressful market situations as the ESG-conscious clientele (investors) are less prone to speculative trading; in addition, the speculative value of such firms is limited since they are already priced at a premium and less attractive to speculators. We examine whether and how stock returns to the high ESG firms differ from those of the low ESG firms across extreme market volatility periods. Using the recently introduced ESG weight-tilted Hang Seng Index (HSIESG), this study also documents the performance of the index compared to its parent Hang Seng Index (HSI).

The value-weighted free-float adjusted Hang Seng Index is the gauge of the blue-chip stocks listed on the Hong Kong Stock Exchange (SEHK)[2]; it is also the underlying of the first Hong Kong index ETF, i.e., the Tracker Fund. The (ESG) weight-tilted Hang Seng Index (HSIESG) is constructed by shifting the original Hang Seng Index portfolio weights from the lower to higher ESG-rated firms while maintaining the set of constituent stocks of the parent index[3]; these features of the ESG infused index allow a direct test of the impact (if there is any) of the tilted weights on the performance and volatility-return characteristics relative to the parent index.

However, unlike the highly distinguishable ESG-driven performance differential of

[1] An important discussion is whether ESG ratings are forward looking but ESG scores are not. These two terms are used interchangeably in this paper.

[2] The Hong Kong Stock Exchange (HKSE) is a subsidiary of the Hong Kong Exchanges and Clearing Limited (HKEX).

[3] The tilts are based on the ESG scores provided by the Hong Kong Quality Assurance Agency (HKQAA).

a best-in-class index compared to its broad-based parent index such as the S&P 500 (Giese, Lee, Melas, Nagy, and Nishikawa, 2019); it is expected to be difficult to discern how the tilted weights affect the performance of the narrow-based Hang Seng Index because the ESG infused index and parent index are highly correlated. Moreover, Friede, Busch, and Bassen (2015), in their highly comprehensive meta-analysis, document a weak correlation between ESG and the performance of equities investments, a finding which further lowers the expectation that the HSIESG can significantly outperform the parent index. Indeed, our study finds that the returns of the weight-tilted HSIESG and the parent index have a correlation of over 99%, which explains why only minor improvements in performance are found from the weight-tilted index. Nevertheless, the paper shows a subtle but significant negative and asymmetric relationship between the average returns of the two indexes and the change in index option implied market volatility. The asymmetrical volatility-return relationship is defined by an observation that the positive return associated with a drop in volatility is less than the magnitude of the negative return triggered by an equal rise in volatility.

We find that the returns on both indexes have a negative relationship with changes in VHSI, a common proxy for movements in current and perceived future market volatility. Most importantly, this study finds that the response to the volatility of the ESG-infused index return is significantly weaker than that of the parent index during volatile periods, a crucial phenomenon that led to the substantially higher holding period return of HSIESG than that of HSI. This result supports the proposition that firms with high ESG ratings are less susceptible to trading pressures triggered by volatility-induced turnovers. The evidence also shows that the ESG weight-tilted index is more resilient to volatility spikes than the parent index, suggesting that stocks with high ESG ratings can be a hedge against extreme adverse market movements. The paper contributes to the literature by providing significant incremental information on the emerging market for ESG-related equity products in Hong Kong.

The rest of the paper is organized as follows: after the introduction in section 1 above; section 2 reviews related studies; section 3 describes the data and methodology for the empirical analysis; section 4 summarizes and interprets the findings, and section 5 concludes.

2. Literature review

Evidence of the market's preference for ESG-related financial products

The International Monetary Fund (2019) finds that the demand for ESG equity investment funds has accelerated in recent years. Conversely, the Brown Brothers Harriman's (2019) survey reveals that ESG exchange-traded funds (ETFs) are among the top 5 ETF sectors that investors prefer to be available in the Hong Kong market. Furthermore, Moody's (2020) study finds that stock indexes attract greater interest when the data compiler incorporates ESG factors in the index products. As ESG-related securities attract fund flows, the funding costs and capital constraints of firms with high ESG ratings can be substantially reduced through the issuance of equity securities; consequently, the lower required return produces healthier valuations of the stocks and creates for investors' higher risk-adjusted returns.

Wu and Juvyns (2020) show that the growth in fund flows into ESG related equities was uninterrupted by the economic and financial turmoil caused by the COVID-19 pandemic; for instance, in the US during Q1 2020, ESG-related open-end mutual funds and exchange-traded funds (ETFs) received close to US$10 billion of capital inflows, an amount which is more than half of the total for the full year of 2019. During the same period, the market for ESG ETFs experienced only two weeks of insignificant outflows and the MSCI ESG Leaders indexes outperformed their extremely volatile market benchmarks (Authers, 2020). The above findings show that the prices of ESG-related equity products can weather the downside pressure with the support of norm-constrained institutions and ESG-advocate investors in general.

The preference for ESG-infused index funds

Giese, Lee, Melas, Nagy, and Nishikawa (2019) emphasize the benefits to investors of incorporating ESG scores in index construction as the ESG tilted index portfolio combines the value of ESG and passive investment in a high-quality well-diversified portfolio. The available ESG tilted index portfolios can attract large-scale investing towards companies with high ESG ratings which creates a positive feedback effect as good ESG practices increase demand for the tilted portfolio and enhance the risk-adjusted return. Conversely, if ESG practices can improve the risk-adjusted return to investors, then ESG-infused financial products and index funds or ETFs appeal also to investors whose main focus is on the potential financial benefits rather than social benefits (Giese, Lee, Melas, Nagy, and Nishikawa, 2019), an aspect that can further fuel the demand for ESG related index products.

Potential financial benefits from investing in companies with high ESG ratings

An extensive number of studies have examined the association between ESG ratings and firms' financial performance. Friede, Busch, and Bassen (2015) provide a comprehensive meta-analysis that covers over 2200 primary studies and survey articles published over a 40-year period since 1970.[4] The study shows that over 62% of the primary studies find a positive relationship between ESG rating and corporate financial performance (CFP); the relationships are stable over time and the relationships are stronger for emerging markets. The CFP metrics used in the meta-analysis include accounting and market-based risk-return measures.

Gregory, Tharyan, and Whittaker (2014) argue that high ESG ratings and performance improve cash flow to equity holders as stronger ESG attributes strengthen a firm's competitiveness, which leads to higher profitability and higher dividends. The argument is consistent with Fatemi, Fooladi, and Tehranian's (2015) findings that high ESG firms are more likely to attract and retain dedicated employees and loyal customers. Dunn, Fitzgibbons, and Pomorski (2017) show that the MSCI ESG rating is positively associated with the firm's financial performance but negatively related to its risk. To address the correlation versus causality criticism made by Krueger (2015), Giese, Lee, Melas, Nagy, and Nishikawa (2019) provide an empirical analysis of economic explanations of causality.

[4] See also Deutsche Asset & Wealth Management (December 2015) for a summary of the major findings.

Most importantly, Eccles, Ioannou, and Serafeim (2014) argue that ESG reduces systematic risk as a firm with stronger ESG characteristics is less susceptible to market-wide shocks due to higher operational efficiency. Therefore, such a firm also has a lower cost of capital (e.g., by having lower market betas). Hong and Kacperczyk (2009) and El Ghoul et al (2011) argue that the cost of capital can also be a manifestation of higher information transparency and such firms are favored by norm-constrained institutional investors. Godfrey, Merrill, and Hansen (2009) and Oikonomou, Brooks, and Pavelin (2012) argue that ESG reduces financial risk as a firm with a stronger ESG profile has higher compliance standards and better risk management, therefore less vulnerable to idiosyncratic risk, and operational risk is of particular concern that attracts costly lawsuits and settlements. Similarly, Fooladi and Tehranian (2015) argue that high ESG firms are expected to have fewer litigation exposures which lowers the bankruptcy risk against the investors. Giese et al. (2019) also find among MSCI-rated firms that companies with high MSCI ESG Ratings have reduced idiosyncratic risk and an increased buffer against market risk.

Conversely, there are concerns that the inclusion of ESG criteria may reduce returns (see, e.g., Nagy, Kassam, and Lee, 2016) because ESG tilt might underweight stocks with high risk-adjusted returns and overweight stocks with low risk-adjusted returns. The matter is serious as it is related to the investment fund manager's fiduciary duty; however, such concern is lessened after the US Labor Department opined that ESG-related investment decisions made by pension plans do not violate the fiduciary duty of the sponsor and added that incorporating ESG ratings can create both social and financial benefits, according to Friede, Busch, and Bassen (2015). Nevertheless, there are questions raised on whether the ESG rating is precise; for example, Berg, Kölbel, and Rigobon (2020) show that such ratings among six prominent rating agencies are dispersed and mainly driven by divergencies of scope and measurement methodology, in addition to a rater's overall view of a firm. Besides, ESG rating might as well be a surrogate of known return predictors, hence it does not present new valuable information to investors. For example, Melas, Nagy, and Kulkarni (2018) show that ESG ratings have a negative association with the value factor (see, e.g., Fama and French, 2015). In a similar vein, Authers (2020) argues that ESG investing could be a watered-down version of growth investing, with certain sectors such as technology and health care, etc., being over-weighted.

The study focuses on examining whether and to what extent the ESG-weighted-tilted Hang Seng Index is more resilient to market volatility than its parent Hang Seng Index. However, unlike a best-in-class index, i.e., an index or index portfolio constructed with a subset of top ESG-rated firms in a broad-based index such as the Standard & Poor 500, it is widely known that a weight-tilted narrow-based index is expected to be highly correlated with the parent index (see, for example, Giese et al. (2019); consequently, it is highly unlikely that the HSIESG can significantly outperform the parent HSI in any aspect. Therefore, the finding of a significant difference in the risk and return profile between the ESG infused HSIESG and the parent index would provide a strong testimony that the ESG tilted weights have a material impact on the performance of the index portfolio and that the ESG infused portfolio is more resilient to an extreme change in market volatility than the parent index due to a preference buffer.

3. Data and Methodology

Data

Although ESG investing is new to the Hong Kong equities market, the asset management industry has already begun to internalize the opportunity. The Hang Seng Indexes Co. Ltd., the provider of the Hang Seng Index (HSI) and various major Hong Kong stock market benchmark indexes, launched on 14 May 2019 the ESG weight-tilted Hang Seng ESG Index (HSIESG).[5] HSIESG and its parent index are identical in all respects except that the HSIESG is constructed by shifting the index weights from firms with low ESG ratings to firms with high ESG ratings; where tilts are based on the ESG scores compiled by the Hong Kong Quality Assurance Agency (HKQAA). The portfolio weight of a single stock has been capped at 8% for the parent index, the cap will remain in effect for HSIESG if the tilt-adjusted weight exceeds 8%. Furthermore, both indexes are subject to quarterly review.

The index provider has backdated the HSIESG to 8 September 2014. The overall sample covers 1751 daily observations for the period 8 September 2014 to 31 October 2021. The availability of the backdated sample allows a comparison of the findings between the pre-launch period (8 September 2014 – 13 May 2019; N=1148) and the post-launch period (14 May 2019 - 31 October 2021; N=603). However, it is expected that as the ESG score data were available also during the pre-launch period, the market at large should have included the information in their index portfolio and it is expected that the key results from the two subperiods are similar according to Friede, Busch, and Bassen's (2015) finding that the correlation between ESG and CFP are stable over time. The paper uses daily data of HSIESG, HSI, and VHSI retrieved from the Bloomberg terminal; and the daily market factors for the Fama and Macbeth regression analysis are obtained from the Kenneth French Library.

Methodology

I. Performance measurements and comparisons

Conventional risk and return and other performance measures including the distributions of daily return, Sharpe Ratio (SR), maximum drawdown, value-at-risk (VaR), expected shortfall (CVaR) are used to compare the risk and return between the ESG infused and the parent indexes for the overall period and between the pre-launch and post-launch subperiods.

II. Tests for the difference in asymmetrical volatility-return relationships between the HSIESG and HSI

The study first uses conventional multiple regression analysis to examine the volatility-return relationships for both indexes and across the two subperiods. Since the regression results are not robust concerning the underlying return distributions, it is difficult to

[5] The HSCEI ESG Index derived from the Hang Seng China Enterprises Index (HSCEI) was also launched on the same day. However, this study focuses only on the HSIESG.

validate many of the statistical assumptions for parametric testing. Thus, we test the difference in an investment performance measure by block bootstrapping the return time series. In essence, the bootstrapping process splits data into non-overlapping blocks of equal size and uses these blocks to generate new samples. This repeated sampling is used to estimate the sampling distribution of a difference. The approach is used to compare the return distributions across different risk deciles.

III. Tests for differential exposure to various investment factors via Fama and French's (2015) multi-factor model

Fama and French's (2015) five-factor models are used by the paper to assess the differential exposure to various market factors between the ESG tilted HSIESG and the parent index. The results allow an examination of the relative performance between the ESG infused index and the parent index. In their comparative study, Nagy, Kassam, and Lee (2016) show that an ESG tilt investment strategy that overweighs stocks with higher ESG ratings based on global MSCI data outperforms the benchmark. Finding similar results in Hong Kong would suggest that the ESG tilts have effectively incorporated and reflected the market's relative preference for firms with high ESG scores.

4. Findings and interpretations

Table 1 shows the summary statistics of daily returns on the ESG tilted HSIESG, the parent Hang Seng Index (HSI), and daily closing levels of and returns on the option implied volatility index derived from options written on the Hang Seng Index (VHSI). The mean daily returns, as well as the standard deviation of the daily returns, of the two indexes, are not statistically different for the overall and the two subperiods.

Table 2. The table shows the correlations among daily returns of HSIESG and HSI and the levels and returns of VHSI. All correlation coefficients are statistically significant at a 1% level; the high return correlation (>99%) between the two indexes suggests that it is highly unlikely to find any significant differences in the risk and return profiles between the weight-tilted index and the parent index. The negative and over 60% correlation between the two measures of volatility change and index returns are consistent with the widely documented negative volatility-return relationship in the equity markets. The negative volatility-return relationships have strengthened in the recent period for both indexes, and the change in correlations is qualitatively identical for both indexes. It is useful to mention here that the subperiod results do not reveal significantly different correlation patterns between the pre-launch and post-launch periods.

Table 3 summarizes the key performance and risk metrics between HSIESG and HSI. In general, HSIESG has a higher return and lower return standard deviation than those of the HSI, but the differences again are not statistically and economically significant; specifically, the average daily returns are 0.0088% and 0.0084% for HSIESG and HSI, respectively. The two subperiods results are qualitatively similar to those of the overall period. However, in spite of the insignificant differences in the arithmetic mean returns and return standard deviations between the two indexes, the holding period return of HSIESG is substantially higher than its parent index by over 67% (i.e., 3.9657% vs 2.369%), an important result that will be further explored in the subsequent sections.

Table 4 summarizes the test results on the negative and asymmetrical relationships between the index returns and the change in option implied market volatility. The regression results in Panel A shows a highly significant negative relationship between index returns and the two measures in volatility changes; the slope coefficients for both measures of volatility change are negative at the 1% significant level but the intercepts are mostly insignificant. Panel B shows that the intercept dummy and the slope coefficients are significantly negative at 1% with respect to volatility change (ΔVHSI), an indication of the asymmetrical volatility-return relationship between the returns of the two indexes and the volatility change. Conversely, the slope coefficient has fully captured the volatility-return relationship for both indexes with respect to volatility return (ΔlnVHSI). The regression test results further confirm the asymmetric negative volatility-return relationship with respect to the raw change in volatility. Conversely, with respect to the rate of volatility change, we find a highly significant negative volatility-return relationship in the slope coefficient but not in the intercept term. Furthermore, the subperiod results show no significant difference in the volatility-return relationship between the pre-launch and post-launch periods.

Table 5 summarizes the mean daily returns for HSIESG and HSI within each of the 10 bins defined by the deciles of the rate of volatility change. Decile 1 (the bottom volatility change bin) shows the mean index returns on days with the greatest drop in market volatility; whilst decile 10 (the top volatility change bin) shows the mean index returns on days with the steepest rise in market volatility. Consistent with the regression results, the mean returns for both indexes are significantly positive in the bins with an average negative change in volatility, and vice versa. The above findings are qualitatively similar for the two subperiods. We test the statistical significance of the mean returns using a bootstrapping method by resampling 10,000 times the returns to avoid the problem associated with the non-normality of the return distribution. Most importantly, the asymmetrical response to volatility of the ESG-infused index is significantly weaker than the parent index. For the overall period, HSIESG has a lower mean return than the parent index (1.0496% vs 1.1261%) for days with the highest drops in volatility; the opposite is true for days with the greatest spikes in volatility and HSIESG has a less negative mean return than the parent index (-1.6255% vs -1.7235%). Table 6 below shows that the above-mentioned mean return differentials are significant at a 1% level. Moreover, the results from the two subperiods are consistent with those found in the overall period.[6]

Table 6 shows the difference between the mean returns between HSIESG and HSI (ΔlnHSIESG – ΔlnHSI) within each bin defined according to the volatility change

[6] We also considered whether the market cap is the main driver of the differential asymmetric risk-return relationship and the significant holding return gap between the two indexes. By examining a sample of snap shots (since the portfolios weights are changing over time) of the two sets of portfolio weights, we find that the tilted weights have generally migrated downward for the largest stocks. The reason is that the weights of the largest stocks have already reached the cap rate in the parent index, the ESG tilts can only shift their weights downward. Hence, it is unclear whether the ESG performance is related to the market cap of the largest stocks.

decile. We test the differences using a bootstrapping method by resampling 10,000 times the returns to avoid the problem associated with the non-normality of the return distribution. The results show that HSI generally outperforms the HSIESG for days with the largest volatility drop (within the volatility change decile 1 bin); while the opposite is true for days with the steepest rise in volatility (within the volatility change decile 10 bin). The above findings are similar for the two subperiods. As noted in Table 3, the less negative mean return of the ESG infused index in days with the greatest rise in volatility produces a substantially higher holding period return than the parent index (i.e., 3.9657% versus 2.369%) despite the seemingly minor and statistically insignificant difference in the standard deviation of daily returns (i.e., 0.0115% versus 0.0119%).[7] To understand the large difference in the overall holding period return between the two indexes, we calculate the cumulative returns for days included in volatility change decile 1, decile 10, and the rest of the sample period. We find the following results: (1) the cumulative return for days in decile 1 (the top 10% volatility change) is -380% and -399% for HSIESG and HSI respectively; (2) the cumulative return for days in decile 10 (the bottom 10% volatility change) is 343% and 355% for HSIESG and HSI respectively; and (3) the cumulative returns for all other days (decile 2 to 9, both deciles included) are 41.74% and 46.01% for HSIESG and HSI respectively. This result leads to the conclusion that HSIESG has a substantially higher holding period return than the parent index because the investors in the ESG-infused index have significantly less negative returns than the parent index during days with the highest volatility spikes.

Tables 7 and 8 summarize the test results on the sensitivity of HSIESG and HSI returns to systematic risk measures via Fama and French's (2015) multi-factor capital asset pricing model. Table 6 summarizes the results using market factors of the developed international markets; whilst table 7 shows the results using the systematic risk factors of the Asia-Pacific markets excluding Japan. The analysis is extended to examine whether the official launch (vis-à-vis the pre-launch period) of the ESG tilted weights has a material impact on the performance of HSIESG compared to the parent index. The results from the two subperiods are qualitatively similar to those for the overall sample period.

5. Conclusions

This study examines whether and to what extent the ESG tilted weights change the performance of the index portfolio relative to the parent Hang Seng Index. The paper first shows that the daily returns of the two indexes are very highly correlated, a preliminary result suggesting that the effect of ESG tilting is small. Consistent with the above conjecture, we find that the mean and standard deviation of returns are not significantly different between the two indexes.

Despite these similarities, the holding period return of the ESG-infused index is surprisingly higher than that of the parent index by over 67%. The unexpected result

[7] Although, for the overall period, the maximum drawdown of the ESG tilted index is slightly higher than the parent index by 31 basis points, the 95% VaR and the CVaRs of HSIESG for both confidence intervals are lower than those of the parent index. Moreover, the holding period return difference is mainly attributed to the differences in mean returns between the two indexes on days with the greatest drop and the steepest rise in market volatility (please refer to the interpretation of results for Table 5 and 6). We thank the referee for highlighting this issue.

can be attributed to the difference in the strength of the asymmetrical volatility-return relationships between the two indexes for days with the highest and lowest volatility change. Specifically, HSIESG has significantly less-negative returns than the parent index during days with the highest volatility spikes, a result attributable to the investors' preference to hold on to stocks with high ESG ratings during volatile periods. This finding explains why HSIESG has a substantially higher holding period return than HSI and supports the proposition that stocks with high ESG ratings are less susceptible to trading pressures triggered by volatility-induced turnovers. Conversely, the results support our conjecture that ESG ratings are priced in the market making stocks with high ESG ratings less valuable for speculation; while the preference for such stocks buffers against panic selling when the market is adversely affected by a large jump in the fear factor. The paper contributes to the literature by providing significant incremental information on the emerging market for ESG-related equity products in Hong Kong.

Although the result of this study is very preliminary and only based on the newly introduced ESG weight-tilted Hang Seng Index, it sheds light on the potential economic benefits of incorporating ESG information into the construction of stock market indexes. ESG indexes may support the development of relevant index products such as ESG-linked equity ETFs, derivatives, other exchange-traded products, and mutual funds.[8] Growth in such markets may help promote Hong Kong as major sustainability and green financial hub and reinforce its status as a global financial center.[9]

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[8] Currently, there are 36 and 34 investment products linked to the parent indexes HSI and HSCEI, respectively. These products include local ETFs, ETFs listed around the world, Leveraged and Inverse Products in Hong Kong, Classification Fund and Listed Open-ended Fund (LOF) in China, Mandatory Provident Fund (MPF) in Hong Kong, and Index Funds worldwide.

[9] Hong Kong has been proactive in establishing market infrastructure to support ESG investment product development. HKEX has launched on 1 January 2021 the Sustainable and Green Exchange "STAGE" (HKEX, 2020), a pioneer information platform that will act as a central data and information hub on sustainable and green-finance investments. This in turn indicates that the latest development in ESG investing in Hong Kong equities provides incentives for capital to flow into the Hong Kong equities market and support the development of ESG investment products in the region. The platform provides information on ESG-related exchange-traded products (ETPs) listed on the HKEX, to promote more ESG-linked asset classes and products including equities and China derivatives in the future.

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Table 1. Summary statistics of daily returns of the ESG weight-tilted Hang Seng Index (HSIESG), the parent Hang Seng Index (HSI), and daily closing levels of and returns of the Hang Seng Index option implied volatility index (VHSI)

Note: The mean daily returns, as well as the standard deviation of the daily returns, of the two indexes, are not statistically different for the overall sample and the two subperiods. Statistical tests (not reported here) reject the null hypothesis that the return distributions are normal.

	HSIESG return	HSI return	VHSI close	VHSI return
	Full sample (8 September 2014 – October 2021; N=1751)			
Mean	0.0001	0.0001	20.0736	0.0022
Stddev	0.0115	0.0119	5.6591	0.0655
median	0.0004	0.0006	19.1400	-0.0072
Max	0.0437	0.0505	64.8000	0.5839
	Pre-launch period (8 September 2014 – 13 May 2019; N=1148)			
Mean	0.0002	0.0002	19.1027	0.0021
Stddev	0.0109	0.0112	4.8960	0.0624
Median	0.0005	0.0007	18.3200	-0.0058
Max	0.0409	0.0421	41.0100	0.5839
	Post-Launch period (14 May 2019-October 2021; N=603)			
Mean	-0.0001	-0.0001	21.9220	0.0023
Stddev	0.0125	0.0131	6.4966	0.0711
median	0.0003	0.0003	20.4900	-0.0085
Max	0.0437	0.0505	64.8000	0.5102

Table 2. Correlations among daily returns of HSIESG and HSI and levels and returns of VHSI

ΔlnHSIESG the continuous compounded daily returns of HSIESG, ΔlnHSI the continuous compounded daily returns of HSI, VHSI the HSI options implied volatility index, ΔVHSI the daily change of the level of VHSI, ΔlnVHSI the continuous compounded daily returns of VHSI.

All correlation coefficients are statistically significant at a 1% level; the high return correlation (>99%) between the two indexes suggests that it is highly unlikely to find any significant differences in the risk and return profiles between the weight-tilted index and the parent index. The negative and over 60% correlation between the two measures of volatility change and index returns are consistent with the widely documented negative volatility-return relationship in the equity markets. The negative volatility-return relationships have strengthened in the recent period for both indexes, and the change in the correlation patterns are qualitatively similar for both indexes.

	ΔlnHSIESG	ΔlnHSI	VHSI	ΔVHSI
	Full sample			
ΔlnHSI	0.9933			
VHSI	-0.1710	-0.1656		
ΔVHSI	-0.6507	-0.6609	0.1412	
ΔlnVHSI	-0.6414	-0.6534	0.1347	0.9435
	Before ESG index launch			
ΔlnHSI	0.9956			
VHSI	-0.1633	-0.1619		
ΔVHSI	-0.6258	-0.6351	0.1368	
ΔlnVHSI	-0.5941	-0.6049	0.1338	0.9650
	After ESG index launch			
ΔlnHSI	0.9902			
VHSI	-0.1872	-0.1767		
ΔVHSI	-0.6911	-0.6998	0.1548	
ΔlnVHSI	-0.7110	-0.7235	0.1470	0.9368

Table 3. Performance comparisons between HSIESG and HSI

Panel A and B show that the HSIESG has a higher return and lower return standard deviation than the parent index; however, the differences are not statistically and economically significant. Conversely, despite the minor difference in the mean and standard deviation of the daily returns between the two indexes, HSIESG has an over 67% higher return for the overall holding period than HSI (i.e., 3.9657% versus 2.369%).

	Overall 8 Sep 2014 – 19 Oct 2021; N=1751		Pre-launch period 8 Sep 2014 – 13 May 2019; N=1148		Post-Launch period 14 May 2019-Oct 2021; N=603	
	HSIESG	HSI	HSIESG	HSI	HSIESG	HSI
Panel A: performance indicators						
Average daily return (%)	0.0088	0.0084	0.0180	0.0172	-0.0066	-0.0058
Std. dev. of daily returns (%)	0.0115	0.0119	0.0109	0.0112	0.0125	0.0131
Annualized return with daily compounding (%)	2.2448	2.1414	4.6438	4.4228	-1.6464	-1.4485
Holding period return (%)	3.9657	2.369	14.8513	13.3376	-8.3050	-8.3024
Annualized Sharpe ratio mean/std	0.1234	0.1136	0.2687	0.2493	-0.0831	-0.0697
Annualized Sortino ratio (mean/-veStd)	0.1702	0.1567	0.3753	0.3481	-0.1133	-0.0954
Panel B: risk indicators						
Annualized total risk (%)	18.1961	18.8514	17.2829	17.7394	19.8138	20.7955
Annualized downside deviation (%)	13.1882	13.6622	12.3727	12.7052	14.5294	15.1898
Skewness	-0.3325	-0.3166	-0.3282	-0.3172	-0.3270	-0.3032
Kurtosis	2.2559	2.0447	2.2396	2.0758	2.0813	1.7750
VaR @ 95% (%)	-1.905	-2.0266	-1.7577	-1.8222	-2.0559	-2.1933
VaR @ 99% (%)	-3.2057	-3.1761	-2.7991	-2.9723	-3.4547	-4.0334
Expected shortfall (CVaR) @ 95% (%)	-2.7129	-2.8108	-2.5386	-2.6099	-2.9416	-3.0692
Expected shortfall (CVaR) @ 99% (%)	-4.0797	-4.2028	-3.7132	-3.7842	-4.2434	-4.4250
Maximum drawdown (%)	35.9013	35.5914	35.6387	35.5914	26.8623	25.3310

Diagram 1: Time series plot of the daily observations of the levels of Hang Seng Index options implied volatility index (VHSI), and the two stock indexes (HSIESG and HSI) for the period 8 September 2014 – October 2021

The diagram shows the large variations in the perceived market volatility embedded in the Hang Seng Index options prices.

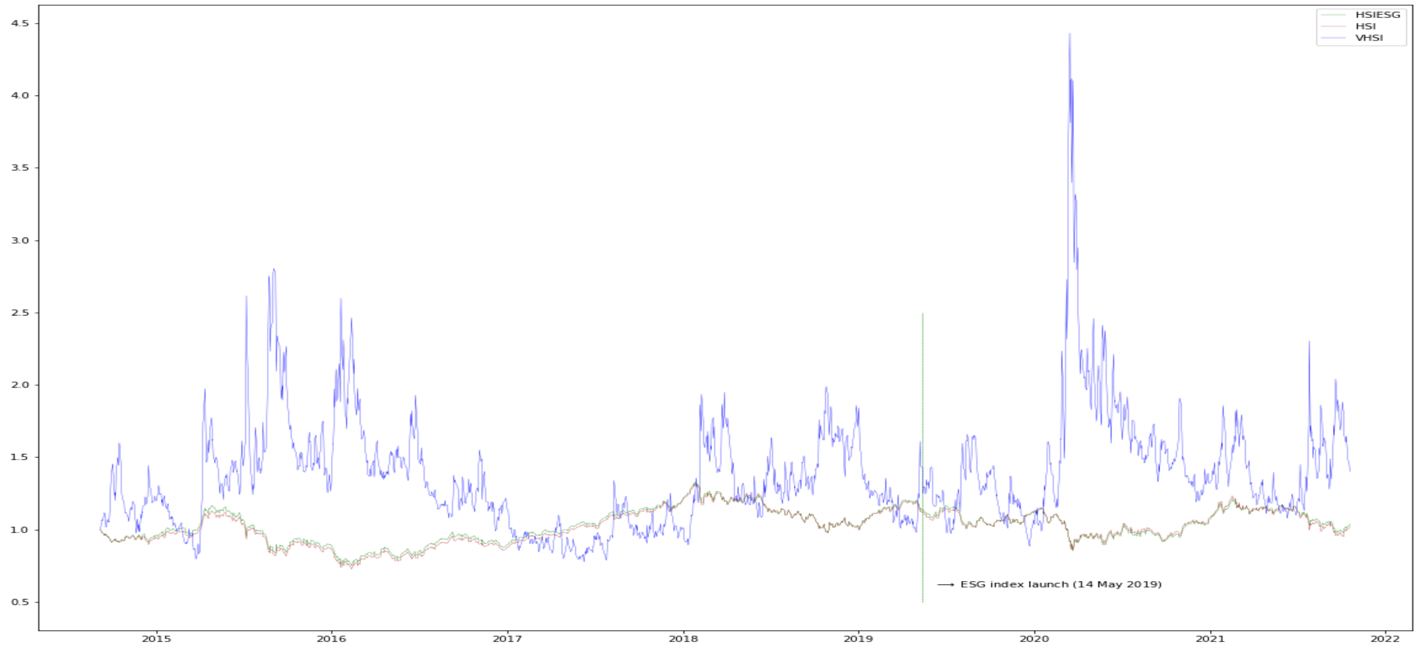

Table 4. Tests of the negative and asymmetrical relationships between the index returns (HSIESG and HSIESG returns) and change in option implied market volatility as measured by ΔVHSI and ΔlnVHSI for the overall sample period (N=1751)

Dependent variable: HSIESG or HSIESG returns

Statistical significance levels of 1%, 5%, and 10% are represented by ***, **, and *, respectively.

Panel A shows the generic result that there is a significant negative relationship between index returns and change in option implied market volatility; the slope coefficients for both measures of volatility change are significantly negative at the 1% level.

Panel B shows the test results on the asymmetrical impact of volatility change on market returns using a dummy variable; where D1=1 if ΔVHSI > 0; 0 otherwise. An asymmetric impact is observed if positive changes in option implied market volatility have a stronger impact on the index returns than negative implied volatility changes. The regression results provide strong empirical evidence of the negative relationship between change in option implied volatility and market returns. The negative slope coefficients are significant at 1%, and the results are robust concerning both indexes and different measures of volatility change. A highly significant (at 1% level) asymmetrical impact of volatility change (ΔVHSI) on returns is observed for both indexes from the coefficient for the intercept dummy; whilst the asymmetrical impact on the slope coefficients is weaker but still significant at 5% and 10% levels for HSIESG and HSI, respectively. Conversely, the asymmetrical effects on either the slope or the intercept term are insignificant with respect to the rate of volatility change (i.e., ΔlnVHSI). All of the above results are valid and essentially identical for the two subperiods (i.e., pre-and post-launch periods), indicating the absence of effect on the market from the official launch of HSIESG. The results for the two subperiods are qualitatively similar to those from the overall period. They are not reported here to conserve space but are available upon request.

	Estimates			
Independent variables	HSIESG	HSI	HSIESG	HSI
Panel A:				
Intercept	0.0001*	0.0001	0.0001	0.0001
ΔVHSI	-0.0046***	-0.0049***		
ΔlnVHSI			-0.1189***	-0.1255***
Panel B: (N=1751)				
Intercept	0.0017***	0.0018***	0.0003	0.0003
ΔVHSI	-0.0036***	-0.0039***		
D1 ΔVHSI	-0.0009**	-0.0007*		
ΔlnVHSI			-0.1166***	-0.1249***
D1 ΔlnVHSI			0.0009	0.0052
D1	-0.0027***	-0.0031***	-0.0005	-0.0007

Table 5: The mean returns of HSIESG (ΔlnHSIESG) and HSI (ΔlnHSI) for each decile of volatility return (ΔlnVHSI) classification for the overall period and the pre-launch and post-launch subperiods

Daily index returns are grouped into ten bins according to market volatility returns. The decile 1 bin contains the returns of the indexes on days with the greatest drop in market volatility, while the decile 10 bin contains the returns on days with the steepest rise in market volatility. The mean returns of the indexes are positive on days in the bins with a negative mean volatility return (i.e., decile 1 to decile 6); whilst the mean returns of both indexes are positive on days in the bins with a positive mean volatility return. The results are consistent for the three periods. The 1% statistical significance level, indicated by ***, is determined via a bootstrapping method by resampling 10,000 times the returns. The positive mean returns for both indexes in the decile 10 bins are less than the magnitudes of the negative returns in the corresponding decile 1 bins, a result consistent for the overall and the two subperiods. The findings show that an up jump in volatility has a greater impact on the index return than a down jump in volatility. Most importantly, the ESG-infused index has a significantly less asymmetrical volatility-return relationship than the parent index. For the overall period, HSIESG has a lower mean return than the parent index (1.0496% vs 1.1261%) for days with the highest drops in volatility; the opposite is true for days with the greatest spikes in volatility and HSIESG has a less negative mean return than the parent index (-1.6255% vs -1.7235%). Table 6 below shows that the mean return differentials are significant at a 1% level.

	Overall			Pre-launch			Post-launch		
Decile	ΔlnVHSI	ΔlnHSIESG	ΔlnHSI	ΔlnVHSI	ΔlnHSIESG	ΔlnHSI	ΔlnVHSI	ΔlnHSIESG	ΔlnHSI
1	-9.0953	1.0496***	1.1261***	-8.5521	0.9139***	0.9788***	-10.0522	1.3110***	1.4060***
2	-4.8753	0.6018***	0.6380***	-4.7405	0.5751***	0.5965***	-5.1077	0.6366***	0.6991***
3	-3.3732	0.4504***	0.4737***	-3.3077	0.4153***	0.4319***	-3.4804	0.5012***	0.5462***
4	-2.3367	0.3418***	0.3534***	-2.2652	0.2854***	0.2977***	-2.4734	0.4751***	0.4931***
5	-1.2689	0.1447***	0.1519	-1.1902	0.2009***	0.2002***	-1.4111	0.0582	0.0628
6	-0.1699	0.0390	0.0515	-0.0936	0.0610	0.0663	-0.3035	0.0148	0.0408
7	1.0704	-0.0478	-0.0637	1.1353	-0.0483	-0.0587	0.9268	-0.0775	-0.1038
8	2.6172	-0.2573***	-0.2899***	2.6346	-0.1870	-0.2040	2.5615	-0.3746	-0.4274***
9	4.9207	-0.6085***	-0.6334***	4.7841	-0.5562***	-0.5867***	5.2033	-0.8251***	-0.8652***
10	12.7039	-1.6255***	-1.7235***	11.9064	-1.4779***	-1.5480***	14.0373	-1.7779***	-1.9015***

Table 6: The differential mean returns between HSIESG and HSI (ΔlnHSIESG – ΔlnHSI) for each decile of volatility return classification
The 1% statistical significance level, indicated by ***, is determined via a bootstrapping method by resampling 10,000 times the returns.
The results show that HSI generally outperforms the HSIESG for days with the largest volatility drop, as shown in the results from the decile 1 bin; while the opposite is true for days with the steepest rise in volatility and is shown by the findings in the decile 10 bin. The above findings are similar for the two subperiods. As noted in Table 3, the less negative mean return of the ESG infused index in days with the greatest rise in volatility produces a substantially higher holding period return than the parent index (i.e., 3.9657% versus 2.369%) despite the seemingly minor and statistically insignificant difference in the standard deviation of daily returns (i.e., 0.0115% versus 0.0119%). This result leads to the conclusion that HSIESG has a substantially higher holding period return than the parent index because the ESG-infused index has a significantly less negative mean return than the parent index on days with the highest volatility spikes (i.e., the decile 10 bin); moreover, the positive mean return differential (ΔlnHSIESG – ΔlnHSI > 0) in bin 10 is greater than the magnitude of the negative mean return differential (ΔlnHSIESG - ΔlnHSI < 0) in bin 1. To understand the large difference in the overall holding period return between the two indexes, we calculate the cumulative returns for days included in volatility change decile 1, decile 10, and the rest of the sample period. We find the following results: (1) the cumulative return for days in decile 1 (the top 10% volatility change) is -380% and -399% for HSIESG and HSI respectively; (2) the cumulative return for days in decile 10 (the bottom 10% volatility change) is -343% and -355% for HSIESG and HSI respectively; and (3) the cumulative returns for all other days (decile 2 to 9, both deciles included) are 41.74% and 46.01% for HSIESG and HSI respectively.

	Overall		Pre-launch		Post-launch	
Decile	ΔlnVHSI	ΔlnHSIESG - ΔlnHSI	ΔlnVHSI	ΔlnHSIESG - ΔlnHSI	ΔlnVHSI	ΔlnHSIESG - ΔlnHSI
1	-9.0953	-0.0765***	-8.5521	-0.0649***	-10.0522	-0.095***
2	-4.8753	-0.0362***	-4.7405	-0.0214	-5.1077	-0.0625
3	-3.3732	-0.0233	-3.3077	-0.0166	-3.4804	-0.045
4	-2.3367	-0.0116	-2.2652	-0.0123	-2.4734	-0.018
5	-1.2689	-0.0072	-1.1902	0.0007	-1.4111	-0.0046
6	-0.1699	-0.0125	-0.0936	-0.0053	-0.3035	-0.026
7	1.0704	0.0159	1.1353	0.0104	0.9268	0.0263
8	2.6172	0.0326***	2.6346	0.017	2.5615	0.0528
9	4.9207	0.0249***	4.7841	0.0305***	5.2033	0.0401
10	12.7039	0.098***	11.9064	0.0701***	14.0373	0.1236***

Table 7. Sensitivity of HSIESG and HSI returns to systematic risk factors – developed international markets

Fama and French's (2015) five-factor models are used by the paper to assess the differential exposure to various market factors between the ESG tilted HSIESG and the parent index. The results allow an examination of the relative performance between the ESG infused index and the parent index.

Dependent variable: HSIESG return or HSI return

Independent variables are the market factors in the Fama Macbeth equation, they are

Mkt-RF market risk premium for developed international markets

SMB return differential between small- and large-cap stocks in developed international markets

SMB (size factor) return differential between small and large-cap stocks in developed international markets

HML (P/B factor) return differential between high and low book-to-market stocks in developed international markets

RMW (profitability factor) return differential between stocks of high and low operating profitability in developed international markets

CMA (pro-growth factor) return differential between aggressive and conservative companies in developed international markets

WML (momentum factor) winners minus losers in developed international markets

All time-series regressions use HAC standard errors of Newey West (1984) with 63 lags; a statistical significance of 1% is indicated by represented by ***. The sensitivity of the two index returns to systematic risk factors are similar

	HSIESG	HSI	HSIESG	HSI	HSIESG	HSI	HSIESG	HSI	HSIESG	HSI
					Full sample period					
Intercept	-0.0002	-0.0002	-0.0002	-0.0003	-0.0002	-0.0003	-0.0003	-0.0003	-0.0003	-0.0003
Mkt-RF	0.5276***	0.5473***	0.6689***	0.6994***	0.6682***	0.6986***	0.6083***	0.6310***	0.6085***	0.6312***
SMB			0.7783***	0.8310***	0.7790***	0.8318***	0.7430***	0.7895***	0.7427***	0.7891***
HML			0.0007	-0.0199	-0.0204	-0.0430	0.3829***	0.4000***	0.4027***	0.4206***
RMW							0.1795	0.1759	0.1858	0.1825
CMA							-0.8075***	-0.8954***	-0.8148***	-0.9030***
WML					-0.0223	-0.0245			0.0164	0.0172

Table 8. Sensitivity of HSIESG and HSI returns to systematic risk factors – Asia-Pacific markets excluding Japan

Fama and French's (2015) five-factor models are used by the paper to assess the differential exposure to various market factors between the ESG tilted HSIESG and the parent index. The results allow an examination of the relative performance between the ESG infused index and the parent index.

Dependent variable: HSIESG return or HSI return

Independent variables are the market factors in the Fama Macbeth equation, they are:

Mkt-RF market risk premium for Asia-Pacific markets excluding Japan

SMB (size factor) return differential between small and large-cap stocks in Asia-Pacific markets excluding Japan

HML (P/B factor) return differential between high and low book-to-market stocks in Asia-Pacific markets excluding Japan

RMW (profitability factor) return differential between stocks of high and low operating profitability in Asia-Pacific markets excluding Japan

CMA (pro-growth factor) return differential between aggressive and conservative companies in Asia-Pacific markets excluding Japan

WML (momentum factor) winners minus losers in Asia-Pacific markets excluding Japan

All time-series regressions use HAC standard errors of Newey West (1984) with 63 lags; a statistical significance of 1% is indicated by represented by ***. All time-series regressions use HAC standard errors of Newey West (1984) with 63 lags; a statistical significance of 1% is indicated by represented by ***.

The results show that the change from the developed market to Asia-Pacific systematic risk factors produce largely similar findings.

	HSIESG	HSI	HSIESG	HSI	HSIESG	HSI	HSIESG	HSI	HSIESG	HSI
	Full sample									
Intercept	-0.0001	-0.0002	-0.0001	-0.0001	-0.0002	-0.0002	-0.0000	-0.0000	-0.0001	-0.0001
Mkt-RF	0.9793***	1.0079***	1.1317***	1.1519***	1.1063***	1.1269***	1.0595***	1.0774***	1.053***	1.0714***
SMB			0.1220	0.1301	0.0391	0.0485	-0.093	-0.0847	-0.1135	-0.1035
HML			0.6446	0.5894	0.7078	0.6516	0.4508***	0.4095***	0.4811***	0.4373***
RMW							-0.5372***	-0.5283***	-0.5177***	-0.5104***
CMA							-0.5325***	-0.5677***	-0.5221***	-0.5582***
WML					0.1591	0.1567			0.0530	0.0486