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Do Green and Dual-Listed Stocks Mitigate Downside Risk?

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Abstract

A new stock pricing framework that generalizes negative returns by focusing on downward movements of a market is downside risk which leads investors to seek compensation for holding stocks with negative returns. This study provides an in-depth analysis of how green stocks act as a hedging tool for diversifying downside risk. This study compares the performance of dual-class and locally listed green and non-green stocks to measure whether the greenness of securities provides a premium to investors for mitigating downside risk. Results proved that the greenness of stocks reduces the downside risk for both cross-listed and local stocks by a significant value compared to non-green stocks. However, dual-listed stocks are less vulnerable to downside risk than local stocks. On the other hand, multiple company and economy-based factors are also measured to evaluate their robust role in determining downside risk. Findings proved that size, growth, and liquidity are strong determinants of downside risk. Inflation rate, interest rate, and exchange rate contribute highly to determining downside risk. On the other hand, the book-to-market ratio, FDI, and GDP emerged as an insignificant determinant of downside risk.

Keywords: Green Stocks, Downside risk, Dual-listing, Alternative investment market.

INTRODUCTION

In traditional finance, variance-based methods are most used to measure risk. Among them, CAPM beta is the most applied tool for measuring risk. Beta is considered now an incomplete and poor metric to measure risk as it is agnostic and depends on the assumptions of normal distribution (Naeem,et al., 2023). There is a growing literature that has provided evidence about the inadequacy of beta to compute the security returns in the markets, where security returns are asymmetric and not normally distributed (Mzoughi et al., 2022, Dahlquist & Tédongap 2017). Market returns hardly exhibit symmetrical distribution and more commonly follow non-normal divisions. In such markets where investors exhibit semi-variance behavior, downside risk metric, downside beta, and downside CAPM have been reported as more acceptable alternative dimensions of risk measurement. The breakdown of beta into upside and downside beta helps investors to analyze portfolio risk more intelligently. Downside beta determines the sensitivity of a stock when the markets are declining as well and the downside risk is said to be the risk of a stock's return which is strongly correlated with the declining market (Ahmad, et al, 2025).

Financial economics has long been identified as the involvement of downside risk in stock appraising. In the early 50s, Roy (1952) came up with the idea of safety-first investors who are more concerned with lessening the possibility of negative returns. Markowitz (1959) also highlighted the significance of downside risk by recommending the implementation of semi-variance as compared to variance as a risk measurement tool. Later, various researchers i.e. Hogan and Warren (1974), and Harlow and Rao (1989) went beyond the CAPM model and identified various frameworks that describe the lower fractional moments in a symmetrical context. Kahneman and Tversky (1979) contributed significantly to this domain by suggesting that investors show more concern for downside loss as compared to gain while making an investment decision. It is a well-known fact that the investors react contrary to securities that are co-vary with the negative market movements rather than those that correlate with the upward market trends. Investors show more interest in reducing the downside risk while making investment decisions for two reasons 1) asymmetric distribution of stock returns and 2) investors' concern for safety first (Huseni,et al., 2025).

Consequently, downside risk allows investors to make appropriate decisions when faced with asymmetric stock return distributions. Given these dynamics, Ang, et al, (2006) argued that stocks that are more responsive to market slumps than rising markets are unattractive for risk-averse investors as these stocks will generate fewer payoffs. Olasehinde-Williams, & Saint Akadiri, (2025) proved that downside beta has a larger explanatory power to measure volatile returns and investors only desire a premium for downside beta rather than traditional CAPM. Teh, & Lau (2017) analyzed that in the Malaysian market, stock returns follow increasing and decreasing market movements. He observed that investors are compensated with an additional return for holding a stock in a declining market. Based on these literature strands, the current study adds to economic and financial literature on downside risk by identifying how green and non-green stocks bring change in results both in local and international markets.

Downside risk computes the sensitivity of excess security returns to excess market returns during declining market scenarios. A market downturn refers to the periods during which the excess market returns are lower than its mean value (Bhat, & Ikram, 2025). This study addresses the gaps in previous literature by examining the downside risk of green and non-green stocks in the context of the Alternative investment market (AIM) which is one of the world's leading green markets. The current study addresses the following objectives by dividing stocks into two categories green and non-green and evaluates whether greenness lowers downside risk or not.1) Determining risk of stocks by grouping them based on domicile i.e. dual-listed and local listed. 2) Measuring the robust contribution of multiple companies and economy-based factors for determining the downside risk.

Literature Review:

Downside Risk of Green and Non-Green Stocks:

Literature strands on downside risk have currently received a lot of attention, owing to high global demands of combating market fluctuations. On the other hand, in the finance literature, studies on green stocks are acquiring momentum, particularly regarding their association with conventional stocks (Tan et al., 2021). In finance, multiple models have been presented to explain downside risk. At first, Roy (1952) introduced the concept of safety investors and then Markowitz (1959) suggested a semi-variance metric to compute the asymmetric distribution of returns.

Moreover, the Single index model by (Sharp 1963) also explains the pricing behavior of stocks initiated by market movements. On the other hand, APT and CAPM have been heavily criticized due to their inefficiency in explaining the asymmetric distribution of returns resulting in the development of DCAPM (Hogan and Warren 1974) and DR-APT (Baghdadabad & Glabadanidis, 2014). These new models introduce novel methods for measuring risks i.e. semi-variance, semi-covariance, and semi-deviations rather than

variance and standard deviation and explain asymmetric behavior of returns. After the realization of such concepts, economists have recognized that investors perceive downside losses differently than upside gains because they expect a premium in the form of additional return for holding stocks having high downside risk. After highlighting the significance of downside risk by these models in the finance literature, multiple studies have been conducted to explain the risk-return trade-off in the context of market downward movements (Siswanto et al., 2022).

Currently, finance literature places special focus on measuring the association between downside risk and returns of equities. Söderman & Haglund, (2024) computed the down-tail risk of securities in the market of China and proved that stocks with lower-tail dependence risk earn high future returns. Sanz Cedrón, (2023) measured downside risk by using value-at-risk and reported a reduction in expected returns as well as a negative relationship between the value at risk and future returns. Schneider et al., (2020) compared different market situations of the Australian market by computing downside, upside, and co-skewness. They concluded that returns of stocks listed in the security market of Australia and downside risk are strongly linked with each other, but no association has been reported among upside and downside risk.

On the other hand, after the Paris Agreement of 2015 companies are restricted to produce zero carbon by greening their operation and investment. As per the stakeholder model, companies are responsive to the prospects of their internal and external cohorts while executing investment and strategic plans (Rubbaniy,et al.,2022). Currently, stakeholders' beliefs have shifted towards the emerging challenges regarding environmental hazards, natural disasters, and the high release of greenhouse gases. The theory assumes that sustainable practices of firms strengthen the bonding between investors and firms leading to the reduction of market risk and financial cost (Reber, et, al., 2022). According to (Reboredo, & Ugolini, 2018), both individual and institutional investors have now become highly concerned about the footprints of their holdings. In the pursuit of GHGs' significance as a major reason for causing global warming, investors put special focus on the assessment of companies' release volume of carbon.

Pavlova, de Boyrie, (2021) studied the combined effect of green and non-green securities and declared that both have a positive effect on returns as compared to benchmark stocks. Another study (Ng & Zheng 2018) reported the outperformance of green stocks over non-green securities after making the comparison with the benchmark stock (i.e. S&P 500 energy index). Paster et al, (2023) offered a theoretical framework for evaluating how variations in sustainability preferences influence stock prices and concluded that the returns of green firms outperform than of brown (non-green) firms. Other studies (Sanford, 2021; Reboredo, & Ugolini, 2018) documented that security prices have now become highly reactive toward environmental risk and carbon-intensive securities underperform than less carbon-intensive stocks.

Pedersen et al, (2021) measured the performance of the US market and stated that de-carbonization entailing the investment approach permits for performance gains that investors willingly pay premium for. However, the results may vary in other markets which are rich with energy firms in the capital markets. Another study by (Surtee, & Alagidede, 2023) highlighted that in the emerging market of Canada, green investment enhances the risk-adjusted performance of stocks. The study reported that based on risk-adjusted metrics, the energy sector does not affect the market portfolio's performance. Interestingly, they didn't report the successful effect of green investment in Canada provided the uninspiring performance of green stocks. Said & Ouerfelli (2024) identified that the high exposure to systematic risk compensates for the high returns generated by energy firms, making the beta equivalent to the market index. On the other hand, (Tiwari et al., 2023) highlighted that high risk-adjusted returns minimize the ratio of risk exposure of green stocks, especially in the emerging economies of India and China which have a substantial financial stake in the energy markets in terms of market capitalization, and government holdings, etc.

Most of the studies identified in prior literature strands of finance paid attention to addressing the risk when the return distribution is symmetric by using stocks, bonds, and green products. For example, Qu, & Xia, (2024) measured the performance of clean energy security markets by comparing the risk of green and non-green stocks. Another study by Quaye et al. (2024) documented the hedging capacity of green stocks and other assets i.e. gold, bond, oil, and carbon prices. Several other studies (Reboredo and Ugolini, 2020; Quao, 2022) identified the association between green equity and other traditional stocks i.e. securities, exchange rates, oil, and gold prices). Thus, most of the literature focused on risk mitigation by using green stocks when the market exhibits normal behavior but not even a single study focused on diversifying risk during the markets' downturns which is the gap intended to be filled by this study. Hence, the study's lead to the testing of the following hypothesis.

H1: Green stocks have less downside risk than non-green stocks.

The Downside Risk of Dual-Listed Stocks:

The globalization of financial landscapes reflects that dual-class stocks are more beneficial in terms of expanding shareholders' base, accessing financial markets, building relationships with foreign investors, and enhancing demand for the company's securities (Rad Kaftroudi et al., 2020). The financial globalization and deregulations in the early

1990s introduced the concept of cross-listed or dual-class stocks. According to (the World Federation of Exchanges, 2011), approximately 4700 companies listed their shares on foreign exchanges worldwide in 1997. Most of the firms chose the UK, Japan, and the USA for foreign listing. Overseas companies list their shares especially on the stock market of the USA to access capital, diversify risk, and expand growth prospects (Ramak, & Fager Burman, 2022). The frequency of cross-listed companies investing is much higher than non-cross-listed companies (Rambe et al., 2024). Palupi, (2022) stated that companies that list their stocks in foreign markets mitigate their losses timely and manage downward earnings efficiently as compared to their local counterparts. Lee & Kwon (2023) evaluated 79 cross-listed Indian firms and reported that cross-listing had a negative influence on investors' wealth having a negative abnormal return during the pre-listing stage. Liquidity and high transaction costs in the local market are a few reasons to earn negative abnormal returns. The studies lead toward the testing of the hypothesis,

H2: Dual listed stocks have less downside risk than local stocks.

Determinants of Downside risk:

Considering the various strands of previous studies on different stock pricing models to determine risk-return relations in different markets, various factors have been highlighted that affect downside beta under the framework of APT, DR-APT, and single-index models. According to (Teh, & Lau, 2017), the risk dynamics in the APT depend on macroeconomic factors and stock returns also relate to them. According to Arbitrage Pricing Theory (APT), security prices are affected by various macro-economic factors i.e. interest rate, money supply, financial development, GNP, and GDP. Hanif et al., (2021) studied the relationship between macroeconomic factors and downside systematic risk. They applied the DCAPM model to examine the downside beta by considering the sample size of 250 companies over the time frame of 2003 to 2014. They reported that macro-economic factors i.e. inflation rate, GDP, term spread, and government budget deficit significantly affect downside beta. Moreover, they also reported that the inflation rate increases the exposure of investors toward downside risk.

Ferrer et al., (2018) measured the stock returns' changes due to interest rate dynamics by applying an extension of the traditional consumption-based stock pricing framework (CCAPM). They reported a strong association between interest rate and downside risk and reported that risk-averse investors need a negative premium linked with a growing interest rate as the time-durations of increased interest rates are normally durations of strict monetary conditions during which inflation estimations are high and liquidities are restricted. Trinks et al, (2018) observed the macro-economic determinants (inflation rate, exchange rate, economic growth, GDP, and industrial production index) of stock returns in Indonesia by assuming the APT approach. The study highlighted those market movements in Indonesia are highly affected by macro-economic determinants, particularly interest rates and exchange rates. A study conducted by (Dahlquist et. al., 2017) examined how FDI in Taiwan influences downside risk by focusing that FDI companies enhance both revenues and risk. They concluded that downside risk has a positive relationship with FDI. Lambert, & Platania, (2020) highlighted that FDI provides positive outputs in terms of stability, growth of financial sources, improved efficiency, and access to international markets. The expansion of financial sources, fewer costs, and diversified markets help to improve the efficiency of operations, subsequently minimizing the effect of an unpredicted negative shock. Consequently, a lesser downside risk is expected for FDI enterprises (Lee, et al. 2023).

Various firm-level factors have also been identified in previous literature that influence stock returns during upward and downward market movements. For example, Lamichhane, & Rai, (2021) studied the relationship between downside beta and one-month equity returns by including firm-level factors i.e. firm size, the book-to-market ratio, and momentum. They reported that companies having a high B/M ratio and large size have high downside risk betas and higher risk-adjusted expected returns. Currently, Lee, & Kwon (2023) reported a negative relationship between liquidity and the risk-return relationship. They used trading volume to measure liquidity risk and concluded that risk avoiders prefer to invest in liquid stocks**.** Lee, & Lee, (2023) analyzed the risk-return relationship of companies sorted based on environmental and social ratings. They documented that the companies having high ES ratings face less risk as compared to their counterparts with less environmental commitments. Lee, & Wang (2021) observed the impact of environmental commitments of US companies on stock returns and concluded that green practices make companies less vulnerable to risk and generate lower returns. The results of the above studies lead to the testing of the following hypothesis.

H3: Firm based factors such as green stocks, size, book to market ratio, liquidity, growth and economy based factor such as inflation rate, interest rate, exchange rate, GDP, FDI have significant relationship with downside risk.

Methodology:

This section highlights a) the measurements of downside risk and greenness index b) an econometric technique and measurement of downside risk's determinants c) a theoretical model integrating Greenness Index used for measuring the emission of GHGs' volume of a company.

Population and Sample:

The population will include all those firms listed on AIM over the sample period. AIM is a sub-market of London's main market which was started on June 19, 1995. Primarily, there were only ten companies listed on AIM with a total value of £82.2 million. Currently, the market has more than 3700 listed firms including both local and cross-listed firms. The AIM market has been recognized as the single international market where companies are generating more than 50 percent of revenue by investing in environmentally friendly products and services. According to the Green Economy Mark Report 2021, 101 issuers have been recognized with London's main market and AIM. These 101 firms are driving growth in the green economy and are sized by a market capitalization of £ 149 billion. London has now become the world's leading sustainable finance ecosystem. So, the AIM market has been selected for measuring the greenness index of listed stocks where almost every second company is focusing on sustainable investment by greening their business operation.

Sample size:

The sample of the study is divided into two parts a) local stocks and b) dual-listed stocks. Due to time limitations and other constraints, the sample entails 118 companies selected out of 1186 listed stocks on AIM from 2012 to 2020. The period was selected due to the availability of data as data on gases' discharge is available only for those years. Based on population magnitude during the timeframe of 2012 to 2020, the study selected a 10% sample from the 1186 firms by using the stratified proportionate sampling technique. As per this technique, every 10th number has been selected. By taking every 10th number from the 1186 listed companies, 118 companies as 10% *1186=118 are selected after excluding service, financial, and IT-based firms because of their lowest involvement in discharging GHGs. The sample selects 30 dual stocks including 6 from Australia, 8 from the USA, 7 from Canada, 3 from Israel, 1 from Ireland, and 5 from the Cayman Islands. The remaining 88 firms are locally listed in the UK.

Variables' measurement:

Downside risk:

The downside beta is measured through the ratio of covariance to variance. The formula has been used by Bawa and Lindenberg (1977) and ACX (2006).

$$Betadown^{i}_{t} = \frac{COV_{t-250,t-1}\left(r^{i}, \; r^{m} \middle| r^{m} < \mu^{m}\right)}{Var_{t-250,\,t-1}\left(r^{m} \middle| r^{m} < \mu^{m}\right)}$$

Whereas $r^{i} and \; r^{m}$ signifies the stock i's and the market's excess return and μm is the average market excess returns over the past 250 trading days. It means that downside beta measures the sensitivity of a stock's additional returns towards the additional returns of the market on those days when additional market returns lagged from its mean values. The risk-free rate is used to compute excess returns i.e. T-bills rate. The results will be annualized by multiplying them by 365.

Green Stocks:

The greenness index is developed to evaluate the greenness level of a company. The greenness level of a stock is computed by considering the non-availability of emissions released by a company. The same methodology is used by (Mumtaz, M. Z., & Yoshino, N. 2021).

Greenness Index= -[-{proportion of a emission of a sector * weight of CO_2 in overall emission}

= - {proportion of emission of a sector*weight of CH_4in overall emission}

= - {proportion of emission of a sector*weight of N_2O in overall emission}]

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Whereas CO_2, CH_4, and N_2O specify the number of releases of carbon dioxide, methane, and nitrogen oxide. A firm with high emissions of CO_2, CH_4 and N_2O is categorized as a polluting firm and identified as a non-greenness level. The negative sign indicates the low weight of CO_2, CH_4 and N_2O released by a sector. Using the Greenness Index, we split our sample into green and non-green stocks.

Determinants of Downside risk:

Inflation rate is measured by computing the rate of change in consumer price index (Robichek and Cohn 1974).Interest rate is computed by evaluating the discount rate (Thorbecke (1997). Exchange rate is measured by computing the pound value against dollars (Griffin and Stulz 2001). GDP is calculated by computing the growth rate (Ülkü and Baker 2014). FDI is calculated by computing the ratio of foreign investment to total assets as high value indicates the high involvement of a company in overseas investment (Wang et, al., 2019). Size is computed by taking log of market capitalization **(**Gu and Kim, 2002). Book to market ratio is calculated by dividing book value of equity to market value of equity (Gu and Kim, 2002). Liquidity is calculated by computing the trading volume of stocks (Simbolon & Irsan 2017). Growth is calculated by computing the annual percentage change in EBIT (Roh 2002). Dual-listed stock is treated as dummy variable, for secondary listed firm it would be 1 otherwise 0. Green stocks is also treated as dummy variable as 1 indicates green stocks and 0 shows non-green stocks.

Statistical techniques for the downside risk's determinants:

Macro-economic and firm specific determinants of downside risk is computed by estimating the coefficient of following equation.

$$\beta_{it} = \beta o + \beta_2 INF_{it} + \beta_3 INT_{it} + \beta_4 ER_{it} + \beta_5 GDP_{it} + \beta_6 FDI_{it} + \beta_7 Size_{it} + \beta_8 BM_{it} + \beta 9 LIQ_{it} + \beta 10 GRO_{it} + \varepsilon_{it}$$

Whereas β_{it} is the downside beta which is calculated by computing the ratio of covariance to variance. INF is the inflation rate. INT is interest rate, and ER is exchanging rate. GDP is calculated by computing its growth rate. FDI (Foreign direct investment) is measured by calculating the ratio of foreign investment to total assets (INVTA). Size indicated firm size. (B/M) is Book to market ratio. LIQ is liquidity and GRO is the growth of a company.

Findings and Results:

Descriptive Statistics:

Descriptive statistics in table 1 presents the statistics of overall sample of AIM market where reported statistics are derived as the averages.

TABLE 1

	Minimum	**Maximum**	**Mean**	**Std.Deviation**	**Skewness**	**kurtosis**
Returns	-1.63	10.42	-1.2538	1.36929	7.552	58.471
Downside risk	-1.76	.60	-.0018	.28246	-4.054	4.406
Firm size	2.66	9.33	5.3899	1.1422	.360	.577
Liquidity	.00	9.58	3.6464	8.5013	9.465	7.135
Firm growth	-9.89	1.44	9.3349	8.2250	8.165	8.693
Book to market ratio	-4.11	2.59	2.6175	3.58669	2.142	7.601
Greenness	.00	.04	.0179	.00974	.273	-.773
FDI	-9.27	6.07	1.0908	1.73189	.124	-1.372
Inflation rate	2.72	7.57	9.1365	4.95586	.401	-1.172
GDP	-4.25	3.03	1.3935	2.18775	-1.892	2.241

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Interest rate	4.32	6.08	5.1812	.46985	.164	.018
Exchange rate	.50	.69	.5866	.06106	.371	-1.146

Table 1 provides descriptive statistics for the stock returns, downside risk metrics, greenness, and firm-specific and macroeconomic attributes. Stocks' returns in the international sample have a mean value (-1.25) with a standard deviation of (1.36). The mean downside risk is (-.0018) with a standard deviation of (.2824) and is not positively skewed. The minimum (maximum) value is (-1.76), (.60), and leptokurtic. The negative return and downside risk value represent that on average sample firms are sensitive towards downward market situations. While demonstrating firm-specific attributes, firm size has an average value (5.38) with a standard deviation (1.14). The average liquidity and standard deviation values are (3.64) and (8.50). The firm's growth has a mean value (9.33) and (8.22) standard deviation. The mean value for Book to book-to-book-to-market ratio is (2.61) with standard deviation (3.58). Greenness has a mean value (.0179) with a standard deviation (.009) representing that the average sample firms are not implementing green practices. The macroeconomic demonstration indicates that FDI (foreign direct investment) has a mean value (of 1.0908) having a standard deviation (of 1.73). The average inflation rate is (9.13) with a standard deviation of (4.95). The average value for GDP is (1.39) having standard deviation (2.18). The interest rate has an average value (5.18) and a standard deviation (.469). The average value for the exchange rate is (.5866) with a standard deviation (.06106)

Correlation Analysis:

Correlation coefficients are used to address the problem of multicollinearity among variables. Results in Table 2 represent that data is free from the multicollinearity issues due to

low coefficient values among explanatory variables and there is no need to exclude any variable as all explanatory factors are equally important.

Table 2: Correlation Matrix

	Return	Size	Liquidity	Growth	B/M	Greenness	FDI	Inflation	GDP	Interest	Exchange	Downside risk
Return	1											
Size	.013	1										
Liquidity	-.017	-.166	1									
Growth	-.020	-.061	.072	1								
B/M ratio	-.054	-.091	-.035	-.142	1							
Greenness	.008	-.171	.068	.141	.034	1						
FDI	.118	.135	.013	.142	.075	-.058	1					
Inflation	-.113	-.049	.031	-.067	-.135	-.033	-.607**	1				
GDP	.053	-.125	.040	.061	.127	.015	.433**	-.751**	1			
Interest	.084	-.041	.074	-.089	.053	-.010	.084	-.398**	.537**	1		
Exchange	.055	.241**	-.064	-.065	-.033	-.012	.015	.043	-.532**	.191*	1	
Downside risk	-.012*	.018*	-.021*	-.057*	.135	-.075*	.176	-.190*	.146	.026*	.111*	1

Based on the overall sample, the correlation matrix represents that return, liquidity, and firm growth are negatively correlated with downside risk indicating that downward movements of markets generate negative returns for investors. Size is positively associated with the downside risk while book-to-market ratio has zero association with the downside risk. Greenness shows a negative association indicating that greenness helps investors even in compensating downside risk. While examining the correlation between

economy-based factors and downside risk, the inflation rate has a negative association with the downside risk, interest rate and exchange rate have a positive association with the downside risk. While foreign direct investment and GDP don't exhibit any significant association with downside risk.

Pooled regression:

For measuring the impact of the greenness on downside risk, the stocks undergo splitting into green and non-green stocks. Furthermore, the stocks are grouped into local green and local non-green and cross-listed green and dual class non-green stocks to examine how the downside risk varies with respect to such changes. Table 3 displays the results of the theoretical models.

Table 3: Downside risk of green and non-green stocks

		Green stocks	Non-Green stocks	Overall
Local stocks	Downside risk	-.012	.031	.010
		(2.30)*	(2.23)*	(2.13)*
Dual-listed stocks	Downside risk	-.028	.015	-.025
		(2.81)*	(2.71)*	(2.11)*
	Constant	0.026	0..028	0.017
		(1.98)	(1.22)	(1.67)
	R^2	0.33	0.30	0.40
	N	93	24	117

Note: The sample size is of 118 (30 dual and 80 local) stocks listed at AIM from 2012 to 2020. The stocks' returns are computed by categorizing them into green and non-green stocks. Dependent variable is downside risk.

Table 3 indicates that both green and non-green local stocks contribute significantly in explaining downside risk with the (β= -0.012, 0.031, $p < 0.05$). However, the negative sign represents that greenness affects downside risk negatively and reduces it by 1.2%. Dual-class green and non-green stocks also contribute significantly to explaining downside risk with the (β= -0.028, 0.015, $p < 0.05$). Dual-class green stocks negatively influence downside risk by reducing it by 2%. The negative relationship between downside risk and green stocks both in the case of local and dual listed indicates that green stocks can shelter investors by generating sustainable returns even when the market provides negative returns (Reboredo and Ugolini, 2020; Hanif et al., 2021; Palupi, (2022). The positive association between non-green local and dual stocks with downside risk represents a linear risk-return trade-off, indicating no strong compensation for investors to hold stocks with negative returns

The results indicate that overall returns of dual and local stocks also show a strong relationship with downside risk with (β= 0.010, $p < 0.05$) which means that AIM's market can provide investors positive returns even during the downward situations.

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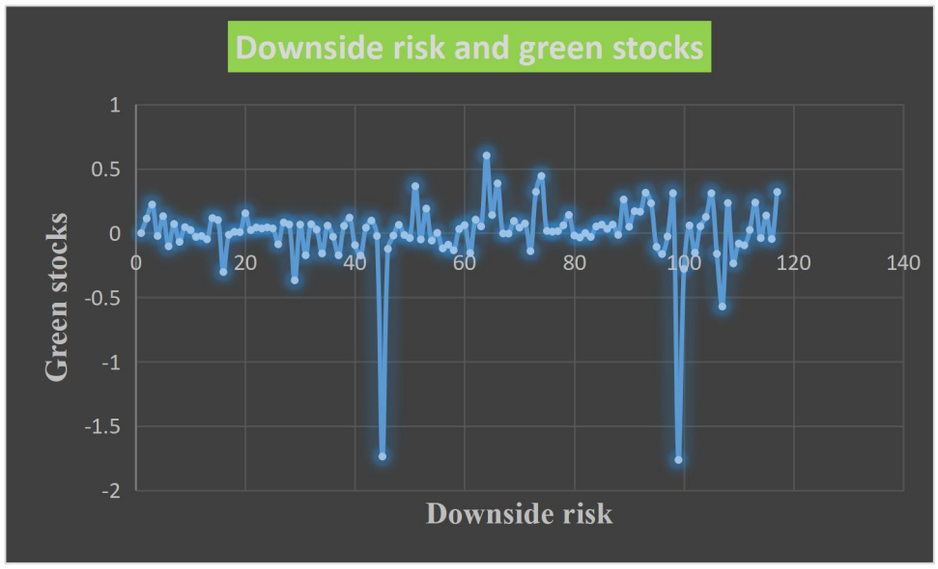
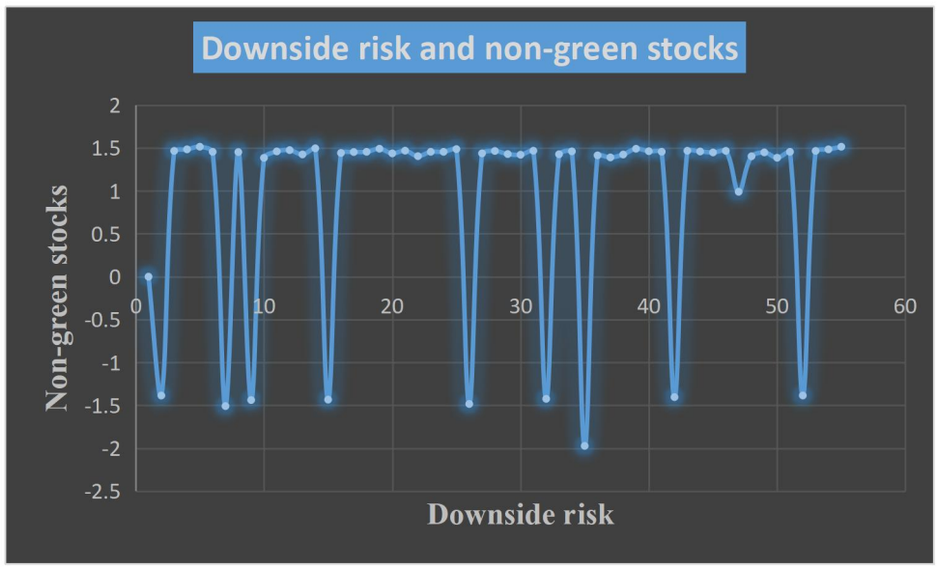
Graphical Comparison of Green and Non- Green stocks:





While comparing the graphs for green and non-green stocks with downside risk, greenness plays a significant role in protecting investment during the market's downward movements than non-green stocks and compensates investors by providing them sustainable returns. In the first Graph, the market exhibits downward movements due to green commitments of companies while in the second graph market undergoes high fluctuations due to ignorance of green commitments which indicates that green stocks not only provide hedging benefits to investors but also contribute highly to stabilizing markets.

The graphical representation and above results lead to the approval of following assumptions.

H1: Green stocks have less downside risk than non-green stocks.

H2: Dual stocks have less downside risk as compared to local stocks.

Determinants of downside risk:

Table 3: Firm based and economy based determinants of downside risk.

	Downside risk	
Determinants	**Coefficient**	**T-Statistics**
Greenness	-0.309	2.34*

Firm-Specific Characteristics	Firm size	-0.021	2.33*
	Firm growth	1.841	1.96*
	Book to market ratio	1.829	1.23
	Liquidity	-0.033	1.91*
Macro-economic Characteristics	FDI	4.562	1.90
	GDP	0.011	1.09
	Interest rate	-0.014	2.10**
	Inflation rate	0.010	1.98*
	Exchange rate	0.058	2.13**
	Returns	-0.019	1.99*
	R^2	0.35	
	N	117	

Note: The sample size is of 117 stocks listed at AIM from 2012 to 2020. The determinants are assumed by categorizing them into firm specific and macro-economic. Dependent variable is downside risk.

For identifying the determinants of downside risk of local and dual-class stocks, greenness, returns and few other factors based on company and economy are assumed. Table 3 presents the estimated coefficient of greenness, and other firm-based factors i.e. size, firm growth, and liquidity (β =-0.309, -0.021, 1.84, -0.033, $p < 0.05$) put strong effect on the downside risk. Results proved that Greenness of stocks has a negative and significant relationship with downside risk. Firm size has a positive and significant relationship with downside risk. Liquidity has a positive relationship with downside risk. Firm growth has a negative relationship with downside risk. However, book to market ratio emerged as an insignificant determinant of downside risk (liquidity (β =1.829, $p>0.05$), opposing the assumption that Book to market ratio has a positive relationship with downside risk. Estimated coefficient for economy-based factors i.e. interest rate, inflation rate and exchange rate (β =-0.04, 0.01, 1.84, 0.05, $p < 0.05$) indicates that all these factors are strong determinants of downside risk. The results suggest that inflation rate has a positive and significant relationship with downside risk. Interest rate has a positive and significant relationship with downside risk. Exchange rate has a negative and significant relationship with downside risk. The insignificant coefficient values for GDP and FDI represent that these two variables are not robust predictors of downside risk, opposing the following inferences that GDP has a negative relationship with downside risk and FDI has a negative relationship with downside risk. Returns also have negative and significant impact on downside risk as coefficient value (β =-0.04, $P<0.05$) displays inverse relationship among downside risk and returns, where investors demand compensation for holding stocks with negative returns during the downward movements of the market. Results proved that green stocks may act as compensation for investors to hold stocks with negative returns as greenness will produce sustainable returns and protect investors from possible losses (Lee & Kwon, 2023).

Conclusion:

The main goal of the study is to identify whether holding green stocks provides hedging benefits to compensate the investors' funds with downside risk. The greenness effect on both local and dual-class stocks is measured to identify whether investors can minimize the loss of holding stocks with negative returns. On the other hand, different firm-based and economy-based determinants of downside risk are also measured by assuming the sample of stocks listed at AIM. The results proved that stock returns as well as marginal changes in local and dual-class stocks changed due to the investors' high fascination with green stocks. Investors' priorities of making green investments can even help them minimize the chances of loss, especially during the downward movement of markets. AIM's companies show strong commitment towards attaining environmental goals and the listed stocks are generating 50% of revenue by greening their operations as per the qualifying requirements of the "Green economy mark".

In Finance, the symmetric distribution of returns with risk frontiers has been recognized as a crucial factor in investment over the years, however, the asymmetric distribution of returns with the frontier of the downside risk is ignored which is the focus of this study. Investors seek compensation for holding negative returns and the rapid emergence of green investment leads them to mitigate downward losses with stocks compatible with environmental effects and climate change. The downside risk is also affected by multiple robust factors which show that investment patterns are highly influenced by various economy-based and company-based factors.

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