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Asset pricing dynamics in sustainable equity portfolios: Evidence from the Pakistan Stock Exchange

Abdul Qadeer[a,b,c], Lieven De Moor[b] and Ashfaq Ahmad[b]

[a]Hailey College of Commerce, University of the Punjab, Lahore, Pakistan; [b]Faculty of Social Sciences and Solvay Business School, Vrije Universiteit Brussel, Brussels, Belgium; [c]Faculty of Business and Management Sciences, Superior University, Lahore, Pakistan

ABSTRACT
Financial markets are an important segment of the economy that can play a critical role in facilitating the attainment of sustainable development goals (SDGs). The equity aligned to these objectives is designed on the principles of Shariah, which are consistent with SDGs In this study, we explore the dynamics of asset pricing in equity, listed on the newly born Pakistan Stock Exchange–Karachi Meezan Index (PSX–KMI) All Share Index as 'Shariah-compliant', using Fama–French asset pricing models. Although our results fail to validate the capital asset pricing model (CAPM), multifactor models perform reasonably well, with exceptions in each model. The value premium seems silent in the five-factor model, whereas the liquidity factor is more attributable in the augmented three-factor model. Despite exceptions, based on the Gibbons, Ross, and Shanken (GRS) test, we confirm the validity of multifactor models to price sustainable equity portfolios (SEPs).

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1. Introduction

Sustainable development goals require significant participation from responsible stakeholders to achieve the desired targets of protecting people and planet (P&P). Financial markets can play an influential role in sustainable development transformation (Schumacher et al., 2020). Correspondingly, equity markets can participate more effectively if financial products are designed to achieve a positive and sustained impact on society. In other words, financial products should contribute and uplift corporations and states, capturing opportunities in transition finance to save P&P and attain SDGs. For that purpose, some financial products, such as sustainability-linked bonds, loans, mutual funds, sukuk[1] and equities that are primarily designed and have the same objectives as SDGs, already exist. Specifically, recent literature (Azmi et al., 2019; Miralles-Quirós et al., 2020) has ategorized 'Shariah-compliant' equity investment as a subset of responsible, ethical, or sustainable investment. De la

CONTACT Abdul Qadeer dr.aqkhan@live.com

Torre et al. (2016) mention that this type of investment is a 'true activity that comes from religious practices such as the ones followed by Muslim, Jewish and Puritan groups who apply religious and ethical codes for doing business and investing'. Different terminologies have been used to describe such investments in recent literature, including 'responsible', 'green', 'ethical', and 'sustainable'. In this study, the 'sustainable equity portfolio' (SEP) is based on Islamic Shariah and listed on the Pakistan Stock Exchange–Karachi Meezan Index (PSX–KMI) All Share Index in Pakistan. Islamic investment is based on principles that result in sustained, positive impacts on P&P in accordance with SDGs.

The term 'transition finance' also supports the cause based on which Shariah-compliant equity or sustainability-linked products are designed. Caldecott (2022) defines transition finance as 'the provision and use of financial products and services to support counterparties, such as companies, sovereigns, and individuals, realise alignment with environmental and social sustainability'. Arguably, this definition opens the door for Shariah-compliant equity to enter the mission of sustainability. Such financialization that may assist developing countries, in particular, meet the desired targets of environmental and social sustainability along with diversified investment opportunities should be introduced and promoted.

Most equities currently listed on the KMI All Share Index were less liquid and known to the public before the inception of the active trading platform in 2015. This index includes Islamic equity in its composition after a screening filter as mentioned in previous studies (Aloui et al., 2016; Jaballah et al., 2018), which distinguishes it from traditional equities. First, the screening filter examines the core business of the company, which must not violate basic principles of Shariah. For example, one is not allowed to invest in a company providing interest-based services, such as those provided by conventional banks; leasing companies; insurance companies; companies involved in production or selling of liquor, haram meat, or pornography; and companies involved in gambling or other activities that are considered to be harmful to society, which are restricted by Shariah. Further, if the main business fulfils the first screening criteria but if they deposit their surplus amount in interest-based accounts or borrow money on interest, the shareholders must express their disagreement with such acts in the annual general meeting. Second, the debt-to-asset ratio should be less than 37%, which makes companies less vulnerable to bankruptcy and takes them toward sustainability. Third, investments other than Shariah-compliant ones should constitute less than 33%. Fourth, the ratio of income earned from restricted sources to total income should be less than 5%. Fifth, the ratio of illiquid assets (raw material, work in process, and fixed assets) to total assets should be greater than 25% as this enables companies with inventory management and sustained sales growth. Lastly, the price of the share should preferably be equal to or greater than the value per share of total liquid assets.

This study contributes to the existing body of knowledge in different ways. First, although pricing for non-Shariah equities has been extensively researched, no effort has been made to study an emerging market like Pakistan considering Shariah-compliant equities as SEPs – one of the paths to sustainability. Second, it describes why the PSX–KMI. All Share Index warrants further research attention. One reason is that such equities were less liquid and known to public, investors, and academia before the launch of their active trading platform in 2015 as a separate and unique market index. Thus, it is important for stakeholders to know more about not only their performance and pricing behaviours but also how this segment of investment performs. Third, recent literature suggests that due to strict screening processes these equities carry distinguished risk–return pattern and pricing. This study aims to provide detailed analysis to help investors make informed investment choices.

However, when we conduct a granular analysis of equity, we find strong evidence of investments routed through these financial products towards projects that are aimed to protect the climate, encourage the use of green energy, and promote social responsibility. Thus, it is also important for investors, policymakers, and practitioners to understand the current standing and pricing dynamics of such equities. In addition, this segment of equity possesses unique characteristics (Derigs & Marzban, 2009) that may play an important role in asset pricing, as price discovery is determined by two additional categories of investors – religious and ethical investors – and this extra source of supply and demand may influence the price formation for such equity (Zaremba et al., 2020).

The rest of the article proceeds as follows: Section 2 provides a review of previous studies, Section 3 explains the data and methodology, Section 4 describes the findings and results and Section 5 mentions the conclusion, policy recommendations, and future research direction(s).

2. Previous studies

Literature on equity, intended to have a positive impact on society in accordance with SDGs, is limited, especially in emerging markets. However, there are sufficient studies on green energy-based investments (Rizvi et al., 2022), environment-friendly green funds (Ji et al., 2021), sustainability-themed mutual funds (Ielasi et al., 2018). A study by Naqvi et al. (2022) on green traded funds also reveals the need of investment consistent with the United Nations' SDGs. Because Shariah-compliant investment is a subset of socially responsible investment (SRI), there is also sufficient literature on Islamic investment (Mirza et al., 2022) analysing risk-adjusted performances and revealing the differentials in the ranking and performance of Islamic funds. The authors also reveal that Shariah-compliant stocks are more resilient to pandemic shock. Additionally, their study is unique, as they researched Islamic funds and traditional counterparts in six countries including Pakistan. Rizvi et al. (2020) study investment funds to understand the dynamics of the risk–return relationship revealed significant implications for investors and policymakers. Likewise, the performance, evaluation, and analysis of each segment of investment has remained a hot topic in the past few decades. Recent studies on green energy have revealed that this unique and well-diversified segment of investment is performing well and is desirable not only for its environment-friendly characteristics but also because of the informed investment choice it offers investors. A study by Umar et al. (2021) on efforts to facilitate green financing also supports the cause of investment being linked to microand macro-level well-being. In short, the financialization of financial products is a growing topic of interest for researchers (Sun et al., 2021; Umar et al., 2021).

Sustainability-linked financial products are important for risk diversification and sustained economic growth. Chatzitheodorou et al. (2019) highlight that sustainable investment distinguishes investment strategy and investment style by fund managers. Referring to the importance of SRI, Berry and Junkus (2013) write that 'it is surprising that there is no consensus of what the term SRI means to an investor'. They also mention that different names are used in the literature including 'social', 'sustainable', 'green', 'impact' and 'moral investment' just to differentiate the strategy by investment managers.

Lagerkvist et al. (2020) emphasise the growing importance of promoting the moral aspect in responsible business practices, resulting in some studies reporting equivalent findings on such investments. Dutta et al. (2020) mention that these investments have attracted the attention of investors as a new investment option and the expected significance of sustainability in terms of its positive impacts on society. Some studies on sustainability-linked investments (Lagerkvist et al., 2020) reveal that investors prefer sustainable as well as environment-focused equity funds. Fang et al. (2019) provide evidence on green equity funds performing better than conventional funds.

One effort on SEPs using the factor-based asset pricing model from an emerging market has been described by Qadeer and Ahmad (2021). Further, Narayan et al. (2016) provide empirical evidence that Islamic equity portfolios are profitable if they move through the price discovery. Based on the above studies, the limited literature on sustainability-linked equity and its pricing dynamics requires further research.

3. Data and methodology

This study uses dividend adjusted monthly share prices for 74 PSX–KMI. All Share Index-listed non-financial companies. The monthly share and index prices, monthly number of shares traded, number of shares outstanding, and monthly risk-free rate is retrieved from Bloomberg. Accounting data that are sorted to form portfolios are collected from the unconsolidated financial statements of sampled companies. They include market capitalisation (price times shares outstanding), book equity divided by market equity (B/M) ratio, investment (change in total assets), and operating profitability (gross profit minus selling, general/other, and administrative expenses, minus interest expense, all divided by book equity) (Fama & French, 2015), and turnover rate (average number of shares traded over the past 12 months divided by shares outstanding) proposed by Datar et al. (1998), which is a widely used measure of liquidity in the literature.

This study considers all 217 companies listed on the PSX–KMI. All Share Index[2] as population for sustainable equity, from which 74 companies are sampled based on:

1. data availability,
2. sharing the same financial year (i.e., July to June),
3. being consistently in the composition of index, and
4. positive B/M ratio.

The sample period and number of shortlisted equities are supported by a previous study (Chakravarty et al., 2004) that analyses the price discovery measure over five years in 60 firms. Additionally, Jiao and Lilti (2017) investigated Fama–French models on monthly data for a period of five years starting from 2010.

Fama–French models have been widely used in the literature, becoming a standard tool for assessing portfolios (Chen & Bassett, 2014). This study follows the work of Fama and French (1992, 1993, 2015, 2017, 2018), Roy and Shijin (2018), Safiullah and Shamsuddin (2021) and Zhang and Lence (2022) among others in the field that use factor-based asset pricing models. This study tests the capital asset pricing model (CAPM) using Fama and MacBeth (1973) methodology, and multifactor models which are based on time-series regression.

Fama and French (1992) contend that the accounting data on which portfolios are formed should be known before the portfolios' returns. Accordingly, all the accounting data is calculated in time t − 1 for the sorting and formation of portfolios at time t. Size-breakpoint for each year is based on median market cap whereas the breakpoints for B/M, profitability (OP), investment (INV), or liquidity (LIQ) are based on 30th and 70th percentiles for 2×3 sorts. For 2×2 sorts, following (Fama & French, 2015), the breakpoints for size, B/M, OP, INV, or LIQ are Size, B/M, OP, INV and LIQ median, respectively. In 2×3, the first sort is always size and second is based on either B/M, OP, INV or LIQ. The three groups for each factor are $H_{B/M}$ (high B/M), $L_{B/M}$ (low B/M) and $N_{B/M}$ (neutral B/M); R_p (robust profitability), W_p (weak profitability) and N_p (neutral profitability); Ci (conservative investment), Ai (aggressive investment) and Ni (neutral investment); L_1 (low liquid), L_3 (high liquid) and L_N (neutral liquid). The equations showing how factors are constructed using 2×3 and 2×2 sorts are given below.

Single-factor model:

$$R_{it} - R_{ft} = a_i + b_i(R_{mt} - R_{ft}) + e_{it}. \tag{1}$$

Fama–French three-factor model:

$$R_{it} - R_{ft} = a_i + b_i(R_{mt} - R_{ft}) + s_i SMB_t \;+\; h_i HML_t + e_{it}. \tag{2}$$

2 × 3 sorts on Size—B/M

$SMB_{2\times3} = (SH_{B/M} + SN_{B/M} + SL_{B/M})/3—(BH_{B/M} + BN_{B/M} + BL_{B/M})/3$

$HML_{2\times3} = (SH_{B/M} + BH_{B/M})/2—(SL_{B/M} + BL_{B/M})/2$

2 × 2 sorts on Size—B/M

$SMB_{2\times2} = (SH_{B/M} + SL_{B/M})/2—(BH_{B/M} + BL_{B/M})/2$

$HML_{2\times2} = (SH_{B/M} + BH_{B/M})/2—(SL_{B/M} + BL_{B/M})/2$

Augmented three-factor model:

$$R_{it} - R_{ft} = a_i + b_i(R_{mt} - R_{ft}) + s_i SMB_t \;+\; l_i ILLIQ_t + e_{it}. \tag{3}$$

2 × 3 sorts on Size—LIQ

$SMB_{2\times3} = (SL_1 + SL_N + SL_3)/3—(BL_1 + BL_N + BL_3)/3$
$ILLIQ_{2\times3} = (SL_1 + BL_1)/2—(SL_3 + BL_3)/2$

2 × 2 sorts on Size—LIQ

$SMB_{2\times2} = (SL_1 + SL_3)/2—(BL_1 + BL_3)/2$
$ILLIQ_{2\times2} = (SL_1 + BL_1)/2—(SL_3 + BL_3)/2$

Augmented four-factor model:

$$R_{it} - R_{ft} = a_i + b_i(R_{mt} - R_{ft}) + s_i SMB_t + h_i HML_t + l_i ILLIQ_t + e_{it}. \tag{4}$$

2 × 3 sorts on Size—B/M or Size—LIQ

$SMB_{B/M} = (SH_{B/M} + SN_{B/M} + SL_{B/M})/3—(BH_{B/M} + BN_{B/M} + BL_{B/M})/3$
$SMB_{ILLIQ} = (SL_1 + SL_N + SL_3)/3—(BL_1 + BL_N + BL_3)/3$
$SMB_{2\times3} = (SMB_{B/M} + SMB_{ILLIQ})/2$
$HML_{2\times3} = (SH_{B/M} + BH_{B/M})/2—(SL_{B/M} + BL_{B/M})/2$
$ILLIQ_{2\times3} = (SL_1 + BL_1)/2—(SL_3 + BL_3)/2$

2 × 2 sorts on Size—B/M or Size—LIQ

$SMB_{2\times2} = (SH_{B/M} + SL_{B/M} + SL_1 + SL_3)/4—(BH_{B/M} + BL_{B/M} + BL_1 + BL_3)/4$
$HML_{2\times2} = (SH_{B/M} + BH_{B/M})/2—(SL_{B/M} + BL_{B/M})/2$
$ILLIQ_{2\times2} = (SL_1 + BL_1)/2—(SL_3 + BL_3)/2$

Fama–French five-factor model:

$$R_{it} - R_{ft} = a_i + b_i(R_{mt} - R_{ft}) + s_i SMB_t + h_i HML_t + r_i RMW_t + c_i CMA_t + e_{it}. \tag{5}$$

2 × 3 sorts on Size—B/M, or Size—OP, or Size—INV

$SMB_{B/M} = (SH_{B/M} + SN_{B/M} + SL_{B/M})/3—(BH_{B/M} + BN_{B/M} + BL_{B/M})/3$
$SMB_{RMW} = (SR_p + SNp + SW_p)/3—(BR_p + BN_p + BW_p)/3$
$SMB_{CMA} = (SC_i + SN_i + SA_i)/3—(BC_i + BN_i + BA_i)/3$
$SMB_{2\times3} = (SMB_{B/M} + SMB_{RMW} + SMB_{CMA})/3$
$HML_{2\times3} = (SH_{B/M} + BH_{B/M})/2—(SL_{B/M} + BL_{B/M})/2$
$RMW_{2\times3} = (SR_p + BR_p)/2—(SW_p + BW_p)/2$
$CMA_{2\times3} = (SC_i + BC_i)/2—(SA_i + BA_i)/2$

2 × 2 sorts on Size—B/M, or Size—OP, or Size—INV

$SMB_{2\times2} = (SH_{B/M} + SL_{B/M} + SR_p + SW_p + SC_i + SA_i)/6 - (BH_{B/M} + BL_{B/M} + BR_p + BW_p + BC_i + BA_i)/6$
$HML_{2\times2} = (SH_{B/M} + BH_{B/M})/2-(SL_{B/M} + BL_{B/M})/2$
$RMW_{2\times2} = (SR_p + BR_p)/2-(SW_p + BW_p)/2$
$CMA_{2\times2} = (SC_i + BC_i)/2-(SA_i + BA_i)/2$

where $R_{it} - R_{ft}$ is the excess return of portfolio i at time t, $R_{mt} - R_{ft}$ is the excess return of the market; hence market risk premium a_i is the intercept of portfolio i, the coefficients b, s, h, r, c, or l are the factor loadings of risk factors that is, Rm–Rf, SMB, HML, RMW, CMA., or ILLIQ, and e_{it} is the error term. The notations used in the equations are borrowed from the asset pricing literature. Premier studies suggest that for regression, where excess returns are used as dependent variables, the model is considered good if the intercept is zero or near zero (Black et al., 1972; Fama & French, 1992, 1993). If the intercept < 0, it means expected risk premiums (i.e., SMB and HML) earn above the actual risk premium (R*i*–Rf) and vice versa (Ji et al., 2021). In any case, if it happens, the asset pricing model fails to correctly predict risk premium on given portfolio. Thus, the performance of portfolios is based on intercept.

To jointly test model validity, the Gibbons, Ross, and Shanken (GRS) test (Gibbons et al., 1989) is widely used in the asset pricing literature. Mosoeu and Kodongo (2022) contend that the lower the value of the individual regression intercept, the higher is the probability that the model will not be rejected by the GRS test. If the *p*-value of GRS becomes insignificant, the model is considered valid.

4. Empirical results

This section describes the empirical results of asset pricing models and basic statistics. Table 1 displays the excess returns and risk of five historical beta ranked portfolios,[3] showing the statistics of the period immediately after the formation period. These statistics reveal that those stocks that were grouped in the lowest beta portfolio in the formation period generate lowest beta and align to average return for the period immediately after the formation period. The statistics in Table 1 are borrowed from the procedure to test the CAPM for which the results are given in Table 9. The results in Table 1 are consistent with the literature, because the second highest beta portfolio (portfolio 4) earns the highest average monthly excess return of 4.567% whereas the lowest beta portfolio generates the lowest average monthly excess return of 1.785% with lowest 0.186 beta risk. As per the formation period, portfolio 5 should have produced the highest excess return and risk; however, the results still hold.

The correlation in Tables 2–5 is low between all the pairs in both sorts except for ILLIQ with Rm–Rf, which is slightly higher. It is worth mentioning that the sign and degree of correlation did not change too much by changing the sorts.

The descriptive statistics of factors from both sorts are shown in Table 6. The Rm–Rf is same for all the models and its construction is unaffected by changing sorts whereas the construction of risk factor SMB is changed. The average return (in %) of market is very low. This is not surprising, with Fama and French (2017) reporting an average market return as low as 0.01% for Japan. The average mean returns for SMB in both sorts are consistent in all formats of models except Fama–French three- and augmented three-factor model where the mean return in percentage of SMB either increased or decreased by changing sorts. For other factors, the mean monthly returns slightly changed by changing the sorts.

Table 1. Excess returns of portfolios and systematic risk.

Name of portfolio	Excess return	Beta
Portfolio – 1	1.785	0.186
Portfolio – 2	2.763	0.290
Portfolio – 3	4.001	0.767
Portfolio – 4	4.567	1.081
Portfolio – 5	4.228	0.873

Source: Authors calculation.

Table 2. Correlation matrix: Fama–French three-factor model.

	Rm–Rf	$SMB_{2\times3}$ $SMB_{2\times2}$	$HML_{2\times3}$ $HML_{2\times2}$
Rm–Rf	1.00		
$SMB_{2\times3}$	−0.280	1.00	
$SMB_{2\times2}$	−0.315	1.00	
$HML_{2\times3}$	0.058	−0.232	1.00
$HML_{2\times2}$	0.346	−0.207	1.00

Note: Rm–Rf (market risk premium), SMB (small minus big) and HML (high minus low) are the risk factors. 2×3 or 2×2 shows sorts.
Source: Authors calculation.

Table 3. Correlation matrix: Augmented three-factor model.

	Rm–Rf	$SMB_{2\times3}$ $SMB_{2\times2}$	$ILLIQ_{2\times3}$ $ILLIQ_{2\times2}$
Rm–Rf	1.00		
$SMB_{2\times3}$	−0.068	1.00	
$SMB_{2\times2}$	−0.153	1.00	
$ILLIQ_{2\times3}$	−0.740	0.010	1.00
$ILLIQ_{2\times2}$	−0.679	0.082	1.00

Note: Rm–Rf (market risk premium), SMB (small minus big) and ILLIQ (low liquid minus high liquid) are the risk factors. 2×3 or 2×2 shows sorts.
Source: Authors calculation.

Table 4. Correlation matrix: Augmented four-factor model.

	Rm–Rf	$SMB_{2\times3}$ $SMB_{2\times2}$	$HML_{2\times3}$ $HML_{2\times2}$	$ILLIQ_{2\times3}$ $ILLIQ_{2\times2}$
Rm–Rf	1.00			
$SMB_{2\times3}$	−0.193	1.00		
$SMB_{2\times2}$	−0.241	1.00		
$HML_{2\times3}$	0.058	0.030	1.00	
$HML_{2\times2}$	0.346	−0.093	1.00	
$ILLIQ_{2\times3}$	−0.740	0.217	−0.107	1.00
$ILLIQ_{2\times2}$	−0.679	0.215	−0.282	1.00

Note: Rm–Rf (market risk premium), SMB (small minus big), HML (high minus low), and ILLIQ (low liquid minus high liquid) are the risk factors. 2×3 or 2×2 shows sorts.
Source: Authors calculation.

Table 7 shows that the average monthly excess returns of size-sorted small portfolios are positive in both sorts. The $SR_{P,\ 2\times3}$ and $SL_{N,\ 2\times3}$ portfolios have highest average monthly excess return with highest standard deviation except $SL_{B/M,\ 2\times3}$ and $SL_{3,\ 2\times3}$ where these portfolios generate slightly higher risk as compared to $SR_{P,\ 2\times3}$ and $SL_{N,\ 2\times3}$. Although changing the sorts resulted in the average monthly excess returns reducing for some portfolios, it increased for a few others.

The average monthly excess return for most big portfolios is negative except for $BW_{P,\ 2\times3}$, $BW_{P,\ 2\times2}$, $BC_{i,\ 2\times3}$, and $BL_{3,\ 2\times3}$, where $BW_{P,\ 2\times3}$ has highest average monthly excess return. Table 8 reveals that VIF is very low and negligible; thus, there is no problem of collinearity between the factors used.

In Fama–MacBeth regression, past beta is used as predictor of portfolios' excess return for the next period. First, betas are calculated, and five quantiles are constructed and grouped based on historical betas. Then, for each time period, cross-sectional regressions are performed on the average monthly returns of each portfolio on historical beta. In Table 9, the intercept is not closer to zero and the insignificant

Table 5. Correlation matrix: Fama–French five-factor model.

	Rm–Rf	$SMB_{2\times3}$ $SMB_{2\times2}$	$HML_{2\times3}$ $HML_{2\times2}$	$RMW_{2\times3}$ $RMW_{2\times2}$	$CMA_{2\times3}$ $CMA_{2\times2}$
Rm–Rf	1.00				
$SMB_{2\times3}$	−0.288	1.00			
$SMB_{2\times2}$	−0.275	1.00			
$HML_{2\times3}$	0.058	0.073	1.00		
$HML_{2\times2}$	0.346	−0.106	1.00		
$RMW_{2\times3}$	0.010	0.049	−0.217	1.00	
$RMW_{2\times2}$	0.049	−0.176	−0.327	1.00	
$CMA_{2\times3}$	0.141	−0.180	0.162	−0.126	1.00
$CMA_{2\times2}$	0.211	−0.168	0.106	0.069	1.00

Note: Rm–Rf (market risk premium), SMB (small minus big), HML (high minus low), RMW (robust minus weak), and CMA (conservative minus aggressive) are the risk factors. 2×3 or 2×2 shows sorts.
Source: Authors calculation.

Table 6. Descriptive statistics of factors.

Factors	Model	Mean	SD
Rm–Rf	All	.005	6.894
$SMB_{2\times3}$	3F	1.852	5.152
$SMB_{2\times2}$	3F	2.006	5.210
$SMB_{2\times3}$	A3F	2.188	4.881
$SMB_{2\times2}$	A3F	1.419	3.272
$SMB_{2\times3}$	A4F	2.020	4.598
$SMB_{2\times2}$	A4F	2.067	4.967
$SMB_{2\times3}$	5F	2.017	5.121
$SMB_{2\times2}$	5F	2.011	5.115
$HML_{2\times3}$	All	.133	7.843
$HML_{2\times2}$	All	−.029	4.940
$RMW_{2\times3}$	All	−.536	5.606
$RMW_{2\times2}$	All	−.444	4.169
$CMA_{2\times3}$	All	1.095	5.667
$CMA_{2\times2}$	All	.817	3.908
$ILLIQ_{2\times3}$	All	−.481	7.965
$ILLIQ_{2\times2}$	All	−.003	4.698

Note: Rm–Rf (market risk premium), SMB (small minus big), HML (high minus low), RMW (robust minus weak), CMA (conservative minus aggressive), and ILLIQ (low liquid minus high liquid) are the risk factors. 2×3 or 2×2 shows sorts.
Source: Authors calculation.

beta coefficient shows the invalidity of the model; however, it is close at the 10% level. The R^2 of 31.14% also confirms the weakness of the model.

The regression results for Fama–French three-factor model in Tables 10 and 11 reveal that intercepts (α) are not perfectly equal to zero in both sorts; however, they are close to zero, indicating that the model absorbs (not perfectly) common time-series variation in excess returns of portfolios and explains the cross-section of average stock returns. The value of intercept for all the portfolios is negative except for $SN_{B/M,\ 2\times3}$, indicating that portfolios are earning lower than the expected return. However, SMB and HML are insignificant for a few portfolios, as shown in Tables 10 and 11. The Rm–Rf is highly significant for all the portfolios. As shown in Table 10, the value of R^2 ranges from 58.5% to 82.1%. As the model effectively describes average stock returns, the other statistic in the regression becomes less important, with the focus remaining on how well exposure to risk factors collectively captures variation in returns 'no matter what else is in the time-series regressions' (Fama & French, 1993). The Greek symbol lambda (λ) in superscript of R^2 shows that for these portfolios Newey–West (HAC)-adjusted standard errors regression is used due

Table 7. Descriptive statistics of excess returns of portfolios.

Portfolios	Mean	SD	Portfolios	Mean	SD
$SL_{B/M,\ 2\times3}$	0.99	12.70	$BL_{B/M,\ 2\times3}$	−0.84	7.62
$SL_{B/M,\ 2\times2}$	1.65	8.64	$BL_{B/M,\ 2\times2}$	−0.60	7.11
$SN_{B/M,\ 2\times3}$	1.80	8.43	$BN_{B/M,\ 2\times3}$	−0.44	8.57
$SH_{B/M,\ 2\times3}$	0.96	10.07	$BH_{B/M,\ 2\times3}$	−0.54	10.81
$SH_{B/M,\ 2\times2}$	1.38	9.35	$BH_{B/M,\ 2\times2}$	−0.38	10.21
$SW_{P,\ 2\times3}$	1.59	9.36	$BW_{P,\ 2\times3}$	0.73	9.71
$SW_{P,\ 2\times2}$	1.49	9.05	$BW_{P,\ 2\times2}$	0.17	8.49
$SN_{P,\ 2\times3}$	1.00	9.48	$BN_{P,\ 2\times3}$	−0.35	9.24
$SR_{P,\ 2\times3}$	2.56	11.18	$BR_{P,\ 2\times3}$	−1.31	7.17
$SR_{P,\ 2\times2}$	1.75	8.94	$BR_{P,\ 2\times2}$	−0.98	7.57
$SC_{i,\ 2\times3}$	1.74	8.74	$BC_{i,\ 2\times3}$	0.03	10.25
$SC_{i,\ 2\times2}$	2.02	8.71	$BC_{i,\ 2\times2}$	−0.26	8.71
$SN_{i,\ 2\times3}$	1.83	9.59	$BN_{i,\ 2\times3}$	−0.23	7.50
$SA_{i,\ 2\times3}$	1.17	10.50	$BA_{i,\ 2\times3}$	−1.58	7.90
$SA_{i,\ 2\times2}$	0.93	8.56	$BA_{i,\ 2\times2}$	−0.80	7.57
$SL_{1,\ 2\times3}$	1.25	7.55	$BL_{1,\ 2\times3}$	−1.91	5.96
$SL_{1,\ 2\times2}$	1.82	8.21	$BL_{1,\ 2\times2}$	−1.00	6.13
$SL_{N,\ 2\times3}$	2.54	10.76	$BL_{N,\ 2\times3}$	−0.83	8.63
$SL_{3,\ 2\times3}$	0.17	11.19	$BL_{3,\ 2\times3}$	0.13	10.58
$SL_{3,\ 2\times2}$	1.13	9.46	$BL_{3,\ 2\times2}$	−0.31	10.23

Note: S shows small and B shows big in size, whereas three portfolios are formed each on book to market (low, high, and neutral B/M), profitability (robust, weak and neutral profitability), investment (conservative, aggressive and neutral investment) and liquidity (low, high and neutral liquid). 2×3 or 2×2 shows sorts.
Source: Authors calculation.

Table 8. VIF statistics.

Factors	3F	A3F	A4F	5F
$Rm\text{–}Rf_{2\times3}$	1.09	2.23	2.22	1.11
$Rm\text{–}Rf_{2\times2}$	1.22	1.89	1.99	1.27
$SMB_{2\times3}$	1.14	1.01	1.06	1.14
$SMB_{2\times2}$	1.12	1.03	1.07	1.13
$HML_{2\times3}$	1.06		1.02	1.09
$HML_{2\times2}$	1.15		1.14	1.33
$RMW_{2\times3}$				1.06
$RMW_{2\times2}$				1.20
$CMA_{2\times3}$				1.08
$CMA_{2\times2}$				1.07
$ILLIQ_{2\times3}$		2.22	2.26	
$ILLIQ_{2\times2}$		1.86	1.88	

Note: HML (high minus low), RMW (robust minus weak), CMA (conservative minus aggressive), and ILLIQ (low liquid minus high liquid) are the risk factors. 2×3 or 2×2 shows sorts. 3F (Fama–French three-factor model), A3F (augmented three-factor model), A4F (augmented four-factor model), 5F (Fama–French five-factor model).
Source: Authors calculation.

Table 9. Fama–MacBeth regression.

Variables	Statistics	t-stat	*p*-value
Beta	2.9331	1.69	0.108
	(1.7390)		
Constant	1.5936	1.00	0.328
	(1.5873)		
Observations	100		
Number of groups	20		
R^2	0.3114		

Standard errors in parentheses.
*** $p<0.01$, ** $p<0.05$, * $p<0.1$.
Source: Authors calculation.

Table 10. Fama–French three-factor model: 2 × 3 sorts on Size—B/M.

	b	*s*	*h*	α	t(*b*)	t(*s*)	t(*h*)	t(α)	R^2
$SL_{B/M}$	1.358	1.145	−0.652	−1.051	11.320	6.950	−6.270	−1.240	0.781
$SN_{B/M}$	0.906	0.760	0.208	0.357	9.540	6.150	1.450	0.470	0.585$^{\lambda}$
$SH_{B/M}$	1.030	1.216	0.698	−1.392	11.980	10.290	9.350	−2.300	0.821
$BL_{B/M}$	0.943	0.121	−0.195	−1.038	11.630	1.080	−2.780	−1.820	0.723
$BN_{B/M}$	1.082	−0.048	−0.005	−0.351	13.10	−0.430	−0.070	−0.600	0.772
$BH_{B/M}$	1.271	0.049	0.455	−0.697	12.52	0.350	5.170	−0.970	0.784

Note: *b*, *s*, *h* and *a* are the factor loadings (coefficients) and t represents t-stat of the factor loadings.
Source: Authors calculation.

Table 11. Fama–French three-factor model: 2 × 2 sorts on Size—B/M.

	b	*s*	*h*	α	t(*b*)	t(*s*)	t(*h*)	t(α)	R^2
$SL_{B/M}$	1.141	0.926	−0.424	−0.221	9.30	7.15	−2.74	−0.38	0.784$^{\lambda}$
$SH_{B/M}$	0.914	0.996	0.874	−0.596	11.79	10.12	8.32	−1.15	0.850
$BL_{B/M}$	0.914	−0.004	−0.126	−0.596	11.79	−0.04	−1.20	−1.15	0.741
$BH_{B/M}$	1.141	−0.074	0.576	−0.221	9.30	−0.57	3.72	−0.38	0.845$^{\lambda}$

Source: Authors calculation.

Table 12. The GRS test.

Model	Mean alpha	GRS	*P*(GRS)	Mean Adj. R^2	Sort
3F	−0.695	1.079	0.387	0.731	2 × 3
3F	−0.408	0.343	0.847	0.795	2 × 2
A3F	−0.612	1.345	0.255	0.628	2 × 3
A3F	−0.494	0.524	0.718	0.713	2 × 2
A4F	−0.762	1.398	0.203	0.686	2 × 3
A4F	−0.492	0.401	0.915	0.764	2 × 2
5F	−0.510	1.107	0.384	0.721	2 × 3
5F	−0.377	0.341	0.976	0.792	2 × 2

Note: 3F (Fama–French three-factor model), A3F (augmented three-factor model), A4F (augmented four-factor model), 5F (Fama–French five-factor model).
Source: Authors calculation.

Table 13. Augmented three-factor model: 2 × 3 sorts on Size—LIQ.

	b	*s*	*l*	α	t(*b*)	t(*s*)	t(*l*)	t(α)	R^2
SL_1	0.982	0.850	0.629	−0.312	7.18	6.53	5.33	−0.45	0.607
SL_N	1.267	0.850	0.138	0.739	4.98	4.54	0.92	0.90	0.652$^{\lambda}$
SL_3	0.531	0.951	−0.720	−2.262	5.27	6.90	−4.85	−2.91	0.767
BL_1	0.704	−0.159	0.425	−1.362	5.00	−1.19	3.49	−1.92	0.332
BL_N	0.921	0.070	−0.151	−1.061	6.84	0.55	−1.30	−1.56	0.709
BL_3	1.155	−0.261	−0.226	0.588	8.73	−2.07	−1.98	0.88	0.813$^{\lambda}$

Note: *b*, *s*, *l* and *a* are the factor loadings (coefficients) and t represents t-stat of the factor loadings.
Source: Authors calculation.

to existence of heteroskedasticity, autocorrelation, or both.[4] As shown in Table 12, the GRS test confirms the validity of Fama–French three-factor model in both sorts.

The intercepts (α) of augmented three-factor model in Tables 13 and 14 show that portfolios are not perfectly equal to zero in both sorts; however, they are close to zero except for SL_3 which is slightly larger with a significant t-stat at the 0.05 level. Overall, the factor loadings of the model collectively describe the variation in excess returns. The intercept value for two portfolios is positive, indicating that they earn higher-than-expected return and vice versa. The GRS test in Table 12 confirms the validity of the augmented version of three-factor model in both sorts. As shown in Table 13, the model's explanatory power ranges from 33.2% to 81.3%.

Table 14. Augmented three-factor model: 2 × 2 sorts on Size—LIQ.

	b	*s*	*l*	α	t(*b*)	t(*s*)	t(*l*)	t(α)	R^2
SL_1	1.102	1.357	0.535	−0.110	9.71	7.71	3.24	−0.18	0.731
SL_3	0.788	1.409	−0.646	−0.877	7.15	8.24	−4.03	−1.46	0.809
BL_1	0.788	−0.091	0.354	−0.877	7.15	−0.53	2.21	−1.46	0.545
BL_3	1.102	−0.143	−0.465	−0.110	9.71	−0.81	−2.82	−0.18	0.827

Source: Authors calculation.

Table 15. Augmented four-factor model: 2 × 3 sorts on Size—B/M or Size—LIQ.

	b	*s*	*h*	*l*	α	t(*b*)	t(*s*)	t(*h*)	t(*l*)	t(α)	R^2
$SL_{B/M}$	1.179	1.062	−0.847	−0.105	−1.100	5.52	7.81	−5.15	−0.84	−1.20	0.733^{λ}
$SN_{B/M}$	0.856	0.916	0.077	−0.021	−0.077	5.76	5.96	0.87	−0.16	−0.10	0.634
$SH_{B/M}$	1.123	1.044	0.515	0.235	−1.112	7.37	6.62	5.68	1.76	−1.44	0.73
$BL_{B/M}$	1.005	0.039	−0.207	0.095	−0.847	8.59	0.33	−2.98	0.93	−1.43	0.722
$BN_{B/M}$	0.975	−0.086	−0.004	−0.123	−0.325	8.34	−0.71	−0.06	−1.20	−0.55	0.780
$BH_{B/M}$	1.061	0.058	0.431	−0.244	−0.835	7.74	0.60	4.45	−2.89	−1.06	0.798^{λ}
SL_1	0.954	0.820	0.248	0.540	−0.185	7.08	5.88	3.10	4.58	−0.27	0.624
SL_N	1.240	1.121	0.001	−0.014	0.261	7.52	6.57	0.01	−0.10	0.31	0.723
SL_3	0.487	1.046	−0.076	−0.881	−2.361	3.14	6.51	−0.82	−6.49	−2.99	0.773
BL_1	0.706	0.030	−0.283	0.391	−1.750	5.49	0.23	−3.71	3.49	−2.68	0.452
BL_N	0.919	0.163	−0.058	−0.179	−1.242	6.87	1.18	−0.73	−1.53	−1.83	0.717
BL_3	1.173	−0.196	0.041	−0.188	0.426	8.65	−1.40	0.50	−1.58	0.62	0.806

Source: Authors calculation.

Table 16. Augmented four-factor model: 2 × 2 sorts on Size—B/M or Size—LIQ.

	b	*s*	*h*	*l*	α	t(*b*)	t(*s*)	t(*h*)	t(*l*)	t(α)	R^2
$SL_{B/M}$	0.964	0.983	−0.539	−0.337	−0.399	7.29	8.73	−3.82	−1.77	−0.71	0.815^{λ}
$SH_{B/M}$	0.943	0.954	0.775	0.162	−0.573	7.35	9.29	4.84	0.72	−1.04	0.826^{λ}
$BL_{B/M}$	0.919	−0.048	−0.125	0.027	−0.505	7.69	−0.53	−0.92	0.13	−0.97	0.742^{λ}
$BH_{B/M}$	0.941	−0.019	0.561	−0.472	−0.331	7.32	−0.16	4.34	−2.67	−0.61	0.869^{λ}
SL_1	1.033	0.911	0.325	0.433	−0.058	9.37	8.12	2.79	2.75	−0.1	0.763
SL_3	0.804	0.995	−0.057	−0.793	−0.937	8.49	9.20	−0.44	−3.49	−1.58	0.834^{λ}
BL_1	0.828	−0.003	−0.157	0.343	−1.005	8.07	−0.02	−1.01	1.42	−1.60	0.557^{λ}
BL_3	1.057	−0.087	0.225	−0.432	−0.126	9.28	−0.75	1.87	−2.66	−0.21	0.837

Source: Authors calculation.

In the augmented four-factor model, the fourth risk factor LIQ is added to the Fama–French three-factor model. Following previous studies (Anjum & Rajput, 2021; Fama & French, 1992, 1993, 2015, 2017; Mosoeu & Kodongo, 2022), six portfolios each are formed on Size—B/M and Size—LIQ using 2 × 3; whereas for 2 × 2 sorts, four portfolios each are formed on Size—B/M and Size—LIQ. The intercepts in Tables 15 and 16 are not perfectly equal to zero in both sorts; however, they are close to zero except for SL_3 and BL_1 in both sorts. The augmented four-factor model captures the common variation in excess returns of portfolios and works well for some portfolios. Some risk factors do not respond completely for a few portfolios. Despite this, the significant factor has sufficient explaining power in terms of R^2. It can also be inferred that augmented four-factor model offers incomplete descriptions of excess returns for $BN_{B/M}$, BL_N, BL_3, and few other portfolios from both sorts. It is also important to mention that for most portfolios, the liquidity factor is not responding. Additionally, SMB and HML are also insignificant for a few portfolios. Still, based on p(GRS) as shown in Table 12, the model is valid in both sorts.

For the Fama–French five-factor model, Table 17 shows the output for 18 portfolios formed on the interaction of Size—B/M, Size—OP, or Size—INV on 2 × 3

Table 17. Fama–French five-factor model: 2 × 3 sorts on Size—B/M, Size—OP or Size—INV.

	b	*s*	*h*	*r*	*c*	α	t(*b*)	t(*s*)	t(*h*)	t(*r*)	t(*c*)	t(α)	R^2
$SL_{B/M}$	1.351	1.011	−.953	−.457	.067	−1.249	10.65	5.85	−8.62	−2.99	0.44	−1.35	0.769
$SN_{B/M}$	.946	.873	.061	.060	−.025	.081	9.92	7.01	0.51	0.49	−0.20	0.12	0.66^{λ}
$SH_{B/M}$	1.019	1.006	.437	−.239	−.077	−1.179	9.46	6.86	4.66	−1.84	−0.59	−1.50	0.735
SR_P	1.25	1.093	.049	.759	.035	.706	11.85	7.60	0.53	5.97	0.28	0.92	0.794
SN_P	.972	.938	.159	−.211	.027	−1.061	7.84	5.56	1.47	−1.41	0.18	−1.18	0.604
SW_P	.952	1.079	−.161	−.785	−.079	−.902	9.91	8.24	−1.92	−6.78	−0.68	−1.29	0.756
SC_i	.938	1.003	−.059	−.105	.603	−.995	11.17	8.78	−0.81	−1.04	5.97	−1.63	0.786
SN*i*	.942	1.226	.142	−.052	.037	−.730	8.18	7.82	1.42	−0.38	0.27	−0.87	0.666
SA*i*	1.269	.683	.146	−.034	−.908	.740	14.45	5.71	1.90	−0.32	−8.60	1.16	0.838
$BL_{B/M}$	.946	.057	−.209	−.053	−.130	−.814	10.75	0.61	−2.38	−0.52	−1.19	−1.36	0.729^{λ}
$BN_{B/M}$	1.071	−.088	−.012	−.099	.030	−.347	12.8	−0.78	−0.16	−0.98	0.30	−0.57	0.779
$BH_{B/M}$	1.278	.062	.40	−.272	.014	−.885	12.81	0.46	4.60	−2.26	0.11	−1.22	0.802
BR_P	.846	.058	−.225	.056	−.11	−1.246	10.08	0.51	−3.07	0.55	−1.09	−2.04	0.683
BN_P	1.228	−.167	.069	−.02	−.099	.049	25.48	−2.31	1.26	−0.34	−1.12	0.13	0.896^{λ}
BW_P	1.143	.072	−.015	−.399	.004	.362	7.73	0.50	−0.14	−2.52	0.03	0.52	0.689^{λ}
BC_i	1.255	−.194	.027	−.084	.234	.113	14.23	−1.62	0.36	−0.79	2.21	0.18	0.828
BN*i*	.946	−.013	−.037	−.039	−.027	−.197	12.23	−0.12	−0.55	−0.41	−0.29	−0.35	0.754
BA*i*	.924	.126	−.178	−.155	−.256	−1.622	9.31	0.93	−2.06	−1.30	−2.14	−2.25	0.635

Source: Authors calculation.

Table 18. Fama–French five-factor model: 2 × 2 sorts on Size—B/M, Size—OP or Size—INV.

	b	*s*	*h*	*r*	*c*	α	t(*b*)	t(*s*)	t(*h*)	t(*r*)	t(*c*)	t(α)	R^2
$SL_{B/M}$	1.123	0.971	−0.508	0.052	0.134	−0.406	9.04	8.4	−2.91	0.32	1.04	−0.76	0.804^{λ}
$SH_{B/M}$	0.92	0.961	0.767	−0.019	−0.161	−0.412	11.28	9.24	6.58	−0.15	−1.22	−0.74	0.846
SR_P	1.002	0.968	0.211	0.744	0.213	−0.039	8.87	10.09	1.26	4.45	1.46	−0.08	0.813^{λ}
SW_P	0.982	0.955	0.036	−0.831	−0.254	−0.599	12.05	9.18	0.31	−6.32	−1.92	−1.08	0.835
SC_i	0.969	1.001	0.039	−0.020	0.585	−0.481	7.96	10.0	0.26	−0.13	3.70	−0.94	0.800^{λ}
SA*i*	1.023	0.904	0.297	0.038	−0.673	−0.322	14.48	10.03	2.94	0.33	−5.88	−0.67	0.862
$BL_{B/M}$	0.931	−0.034	−0.129	−0.024	−0.181	−0.398	11.82	−0.34	−1.14	−0.19	−1.42	−0.75	0.751
$BH_{B/M}$	1.134	−0.025	0.597	0.047	0.114	−0.392	8.86	−0.20	3.38	0.27	0.86	−0.70	0.846^{λ}
BR_P	0.975	−0.047	0.001	0.177	−0.268	−0.593	12.65	−0.48	0.01	1.42	−2.14	−1.13	0.789
BW_P	0.996	−0.034	0.176	−0.247	0.200	−0.033	8.84	−0.36	1.08	−1.45	1.35	−0.06	0.786^{λ}
BC_i	1.018	−0.098	0.228	0.035	0.361	−0.342	13.95	−1.05	2.19	0.29	3.05	−0.69	0.858
BA*i*	0.964	−0.001	−0.030	−0.023	−0.381	−0.501	7.95	−0.01	−0.19	−0.15	−2.37	−0.99	0.726^{λ}

Source: Authors calculation.

sorts. Although, the intercepts (α) for all 18 portfolios are not perfectly equal to zero in 2 × 3 sorts, they are close to zero. The performance and validity of the model solely depends on the intercept in regression where excess returns are used as dependent variables. The corresponding t-stat for intercept is also insignificant for all the portfolios except two (BR_P and BA_i). Additionally, the intercept values are mostly negative, revealing mispricing.

Based on the intercept, this study claims that the risk factors Rm–Rf, SMB, HML, RMW and CMA hold their position to describe common variation in excess returns despite insignificant risk factors for most portfolios. This means that insignificant risk factors do not describe the variation in excess returns. In the five-factor model, for most portfolios, the risk factor HML, RMW and CMA appears silent, indicating that they are not playing the game. The redundancy of HML is not surprising (Fama & French, 2015). However, questions arise for RMW and CMA. Despite insignificant risk factors, the R^2 ranges from 60.4% to 89.6%, indicating that significant risk factors alone explain this variation.

Table 18 shows the findings of 12 portfolios formed on Size—B/M, Size—OP, or Size—INV. Interestingly, the intercept moved toward zero in 2×2 sorts. For this study, 2×2 sorted portfolios perform well in all formats because they do not exclude middle-ranked stocks. The intercept values significantly decreased, which is a good sign for the validity of the model. However, the problem of insignificance of risk factors for most portfolios did not disappear. This is problematic for the asset pricing model for portfolios where the insignificance of risk factors occurs. The R^2 of the model ranges from 72.6% to 86.2%. As shown in Table 12, the p(GRS) is insignificant in both sorts, revealing the validity of the five-factor model for SEPs based on the sample and time period selected in this study.

5. Conclusion

We examined asset pricing dynamics in equity listed on the new PSX–KMI. All Share Index as Shariah-compliant between July 2016 and June 2021. The equity aligned to SDGs is designed on the principles of Shariah that are consistent with SDGs.

Using portfolios and risk factors constructed from 2×3 and 2×2 sorts, Fama–French and augmented models reveal incomplete (but valid) description of the cross-section pattern of stock returns. The risk factors provide significant description for most portfolios, but they reduce the significance for few portfolios in each model. It is not surprising, as asset pricing literature reports such evidence. Consistent with Fama and French (2015), H.M.L. seems to be redundant by adding profitability, investment, or addition of liquidity factor to the Fama–French three-factor model.

Considering their empirical findings, the GRS test validates all the models for the study period and sample. This is due to the zero or close to zero intercept for most portfolios in excess return regression in both sorts. Based on the criteria, however, we confidently recommend factor pricing models to price such equities. Overall, the results are consistent with the literature, revealing that a positive screening may reduce the portfolio performance as the degree of diversification reduces. However, we cannot reject the asset pricing model due to the insignificance of risk factors. We may term this an empirical failure of the models. The findings may assist investors to expand their informed choices, policies, and practices in devising strategies to promote such equities that are designed on the principle of protecting P&P.

The equity selected for this study is based on principles that eventually return sustained and positive impacts on P&P in accordance with the expectations of SDGs. The novelty of this study can help promote research that translates into protecting society, compelling policymakers to support such financialisation and introducing diversified investment opportunities for potential investors. This study opens the door for future research and demonstrates how financial markets can participate in achieving SDGs. This research can be extended by considering other sustainability-themed financial instruments and measurement tools to further strengthen the paths to sustainability. The limitations of the study include the unavailability of high frequency data, cross equity comparison, less generalisability due to small sample, and construction of portfolios on other stock characteristics. Based on the findings, the pricing of SEPs sufficiently responds to the existing pricing models, and hence this study advises policymakers and academia to consider other sustainability-themed financial products measured by the same tools for comparative research.

Disclosure statement

The authors report there are no competing interests to declare.

Notes

1. The Arabic name for financial instruments commonly referred to as 'Shariah-compliant' bonds.
2. Currently, PSX–KMI All Share Index comprises 252 companies for the review period 1 July 2021 to 31 December 2021, for which the recomposed index was implemented on 15 July 2022.
3. Portfolio 1 has the lowest beta stocks and portfolio 5 has the highest beta stocks.
4. Results of heteroskedasticity and autocorrelation are not reported due to space constraints.

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ORCID

Abdul Qadeer http://orcid.org/0000-0002-6757-0812
Lieven De Moor http://orcid.org/0000-0002-1290-2971
Ashfaq Ahmad http://orcid.org/0000-0002-1657-2324

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