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Risk Factors in the Indonesian Stock Market[1]

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Abstract

This paper identifies the relevant risk factors that determine the cross-section of returns in the Indonesian stock market. We examine 152 factors using the Bayesian framework developed in Jensen, Kelly, and Pedersen (2023). Our results show that size, value, quality, and profitability are the characteristics themes that explain future cross-sectional stock returns during the period 1991-2022. Momentum is not significant. We document differences in factor returns for stocks that adhere to Sharia law (i.e., Islamic finance principles). Value and size return patterns occur across all stocks, but significant posterior alphas for quality and profitability reliably exist only within non-Sharia stocks.

JEL classification: G12; G14
Key words: Indonesian stock market; factor returns, stock market anomalies, Bayesian analysis, machine learning

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Abstract

This paper identifies the relevant risk factors that determine the cross-section of returns in the Indonesia stock market. We examine 152 factors using the Bayesian framework developed in Jensen, Kelly, and Pedersen (2023). Our results show that size, value, quality, and profitability are the characteristics themes that explain future cross-sectional stock returns during the period 1991-2022. Momentum is not significant. We document differences in factor returns for stocks that adhere to Sharia law (i.e., Islamic finance principles). Value and size return patterns occur across all stocks, but significant posterior alphas for quality and profitability reliably exist only within non-Sharia stocks.

1. Introduction

Indonesia is soon expected to be the third largest economy in Asia after China and India (Bloomberg, 2022). Indonesia is also an emerging center for Islamic finance and has the largest Muslim population in the world. Figure 1 illustrates the time-series of the level and return of the Indonesian Stock Exchange (IDX) composite index. From 1990 to 2022, the IDX index earned an average annualized return of 24.74% in US dollars. Despite the impressive performance, there is limited academic research on the relevant risk factors in the Indonesian stock market. Without establishing fundamental risk factors, it is difficult to conduct rigorous research in this market. Our aim is to identify the relevant risk factors in the Indonesian stock market and to provide evidence on the importance of Islamic finance.

[Insert Figure 1 here]

We start with 152 asset pricing factors that were originally documented in the US stock market. Our analysis employs the Bayesian selection model developed by Jensen, Kelly, and Pedersen (2023; henceforth JKP). Of the 152 factors, we focus on the 117 factors that were statistically significant using conventional OLS regressions in the original study. We take the perspective of a local Indonesian investor by forming factors using breakpoints from the IDX mainboard. We sort stocks into five groups and form value-weighted portfolios within each of the quintiles. To calculate a factor return, we create a long-short portfolio that buys stocks in the highest quintile and shorts stocks in the lowest quintile portfolio.

Following JKP, we apply the empirical Bayesian (EB) model to estimate robust posterior factor alphas. This methodology addresses the dimensionality problem and considers how investors learn about the market and stock factors over time. Using the EB model, we document that 41 of the 117 initially identified factors have significantly robust posterior alphas during the 1991-2022 sample period. We assemble the factors into 13 clusters according to their characteristic themes. Our results show that value, size, quality, and profitability are the

characteristic themes that most frequently explain the cross-section of stock returns. Consistent with the prior literature (Chui, Titman, and Wei 2010), the momentum effect is not significant. Value is robust, as it generates the highest average posterior alpha (0.37%), and all 15 characteristics that are related to the value effect generate significant posterior alphas. Size (0.28%), quality (0.26%), and profitability (0.24%) also reliably generate significant posterior alphas during this period.

Our findings are potentially useful to investors who trade these characteristic themes because factors such as value have not performed well in developed markets during this time period. Therefore, Indonesia could be an attractive new market for such investors. To take the perspective of foreign investors, we use NYSE non-micro breakpoints (Fama and French, 2015) to construct each factor. Using these breakpoints, value, quality, size, and profitability characteristics themes continue to generate abnormal returns. We also verify that the results are not sensitive to the use of all stock breakpoints in the factor constructions.

Our final analysis investigates the relevance of Islamic finance principles in this market. Indonesia has the single largest population of Muslims, with more than 85% of its population identifying as Muslims. IDX provides a list of Sharia stocks, which the exchange identifies as stocks that operate in accordance with Islamic principles. 53% of the stocks are classified as Sharia stocks. On average, Sharia stocks are older, have lower volatility, and are more profitable. The value characteristic theme performs robustly across both Sharia and non-Sharia stocks but generates higher posterior alphas in non-Sharia stocks (0.38% vs. 0.28%). Size also generates significant posterior alphas in both types of stocks. However, the characteristic themes of quality and profitability perform well only among non-Sharia stocks.

2. Background and literature

2.1 Brief history and current state of the IDX

The Dutch government launched the Jakarta Stock Exchange (JSX) in 1912. In 1989, a second exchange, called the Surabaya Stock Exchange (BES), was established to support economic and financial development. The JSX and BES merged in November 2007, which formed the current Indonesia Stock Exchange (IDX). By 2022, the IDX has become an integrated part of the Indonesian economy, with the total capitalization of the stock market accounting for 48.5% of the country's nominal GDP.

The Indonesian capital market has been open to foreign investments since 1987. Settlement time has been reduced from T + 4 before September 2002 to T + 2 on and after November 2018. In October 2000, the market adopted a multifractional system. Since May 2009, the IDX has allowed short sale transactions on stocks that meet specified criteria on liquidity, financial performance, and trading history. Each month, IDX publishes a list of stocks eligible for short sales. IDX suspended short selling in March 2020 due to concerns about the possible adverse impacts of the COVID-19 pandemic on the financial market.

Like many Asian stock markets, the IDX is dominated by retail investors. Indonesia, however, is unique in that domestic investors have a demand for 'Islamic' financial assets. Islamic investing discourages high uncertainty, unethical investments, and speculative trading, while encouraging risk-return sharing. IDX identifies a list of Sharia stocks, which are companies whose businesses are aligned with Islamic principles.

Many of the major business groups listed on the IDX have pyramidal and cross-holding structures. The parent company has controlling interests in subsidiary companies, resulting in a high concentration of ownership. About 60% of publicly listed firms in the Indonesian market have positive cross-holding. These structures are opaque because there is limited regulation on the disclosure of cross-holdings.

2.2 Literature review

Limited research is available on the Indonesian stock market. Recent studies investigate market liquidity (Rhee and Wang, 2009), corporate governance (Imamah et al., 2019), and the impact of the financial crisis on the market (Herwany et al., 2021). We build on this research by systematically identifying the risk factors that determine the cross section of stock returns. Our aim is to provide the relevant risk factors so that researchers can appropriately account for risk in future studies.

3. Data and Sample

Data on market pricing and financial statement items of Indonesian stocks are retrieved from the Compustat Global Security Daily dataset. Our sample period is from January 1991 to December 2022. Daily data in the Compustat Global Security Database contain errors. We follow Bessembinder, Chen, Choi, and Wei (2023) and Jensen, Kelly, and Pedersen (2023) to clean daily closing prices, trading volumes, and the number of shares outstanding in the raw data. For each firm, we only include the primary issue. For firms with multiple primary issues, we select the one with the longest listing period. Our final sample includes 964 unique common stocks listed in the Indonesian stock market.

We follow previous studies to calculate 152 market-based or fundamental-based firm characteristics (Appendix B provides a list of firm characteristics). When constructing the accounting-based variables, we use the most recent accounting data. We assume that financial statement information is available to the public four months after the fiscal date. When computing market-based variables, we use the most recent pricing data.

[Insert Table 1 here]

Table 1 presents the number of IDX-listed stocks, the total annual trading volume and the aggregated year-end market capitalization of Indonesia stocks by year. The number of stocks listed on the IDX has increased from 137 in 1991 to 784 in 2022. Annual trading volume

has increased from $1.08 million USD to $12.79 billion USD. The market capitalization of the entire market grows rapidly from $7.37 billion USD to $612.16 billion USD.

[Insert Table 2 here]

Table 2 provides descriptive statistics of the stocks listed on the IDX. Panel A presents results for the entire sample. The average stock return is 1.86% per month, which outperforms the risk-free rate 1.72% per month (i.e., 10-year maturity Indonesian government bond). The average monthly total volatility is 17.10%. The average stock has been listed for 23.86 years and has a market capitalization of $616.55 million USD. The average BM ratio is 1.42, and the average gross profit to total asset ratio is 0.23. The total assets of the mean (median) Indonesia firm grow by 109% (5%) per year, which reflects the fact that some firms are extremely aggressive in business expansion.

Only 5% of the shares of Indonesian firms are held by institutional investors, with 0.27% held by domestic institutions and the rest 4.73% owned by foreign institutions. The low institutional holding is due to the high cross-shareholding among firms.

Panel B of Table 2 presents the mean values of firm characteristics grouped by firm size, listing boards, and religious attributes. International investors may use stocks listed on the New York Stock Exchange (NYSE) to gauge the size of stocks listed outside the US. Following JKP, IDX stocks are classified into five groups: mega stocks (with market cap $\geq 80^{th}$ percentile of NYSE stocks), large stocks (with market cap between 50^{th} and 80^{th} percentile of NYSE stocks), small stocks (with market cap between 20^{th} and 50^{th} percentile of NYSE stocks), micro stocks (with market cap between 1^{th} and 20^{th} percentile of NYSE stocks), and nano stocks (with market cap smaller than 1^{th} percentile of NYSE stocks). Only 1.11% of IDX stocks classify into the mega group with an average size of $19.991 billion USD. The majority of stocks fall into the micro group (39.66%) and the nano group (38.57%).

Stocks in the nano group earn the lowest average return (1.26% per month), while small stocks earn the highest average return (2.40% per month). Nano stocks are the most volatile stocks, and mega stocks are the least volatile ones. Mega stocks have the longest average listing history (28.5 years), whereas nano stocks have the shortest ages (average 22.5 years). The average book-to-market ratio decreases with size, suggesting that smaller firms are more underpriced relative to book values. For liquidity, stocks in mega size group have the highest average monthly trading volume of 794.92 million shares, while nano stocks only have around 74.99 million shares traded per month. Firm profitability decreases with stock size, with the mega stocks being the most profitable (with an average GP/AT of 0.499) and nano stocks being the least profitable (with an average GP/AT of 0.194). The asset growth rate also appears to be correlated with the size of the firm. Micro stocks are the most aggressive in firm investments, with an average total asset growth rate of 149%. Mega stocks are the most conversative in expanding business: Their total assets grow by 17% per year on average.

Domestic investors are likely to categorize stocks based on local market capitalization breakpoints. We sort firms into five different size groups by size breakpoints of stocks on the main listing board of the IDX. Mega, large, middle, small, and micro stocks are stocks with market capitalization greater than the 90^{th} percentile, between 60^{th} and 90^{th} percentile, between 40^{th} and 60^{th} percentile, between 20^{th} and 40^{th} percentile, and smaller than the 20^{th} percentile of Main board stocks, respectively. The pattern of firm characteristics across IDX main board size groups is similar to firm characteristics across NYSE size groups. There is no linear relation between average return and firm size. Stocks in the four non-micro groups deliver similar average performances, while micro stocks significantly underperform the other groups. Smaller groups tend to have higher total risk while lower market systematic risk. Larger stocks are more mature firms with a longer trading history, higher trading volumes, a lower B/M ratio, higher profitability, and more conservative investment.

IDX has three listing boards: the Main board, the Development board, and the Acceleration boards. 55% of stocks are listed on the Main board. These stocks are mature and large companies with long operating history. 44% of stocks are listed on the Development board. These stocks have not yet fulfilled the requirements to qualify for a Main board listing. Recently, IDX introduced the Acceleration board, which targets small companies with high growth potential. 0.28% of stocks are listed on the Acceleration board. These companies are the least profitable but grow quickly, with asset growth exceeding 200% per year.

Most Indonesians identify as Muslim, which may require their investments focus on companies that adhere to Islamic principles. To accommodate these preferences, the IDX identifies Sharia stocks, which are firms that adhere to Islamic principles.[2] Individual stocks are evenly split between the two types of stocks. On average, Sharia stocks earn slightly higher returns than non-Sharia stocks (1.93% per month vs. 1.77% per month). Sharia stocks are issued by older, profitable firms with lower trading volumes and lower investment expenditure.

Panel C reports pairwise correlation coefficients between key variables of the full sample. Most firm characteristics do not exhibit high correlations with stock returns with the exception of volatility. Firm size is negatively correlated with volatility and is positively correlated with firm age and profitability, which confirms the pattern documented in Panel B that larger stocks are less volatile, older, and more profitable.

4. Main Empirical Analysis: Factors in the Indonesia Stock Market

4.1 Model set-up

[2] To be classified as a Sharia stock, the issuer should satisfy two conditions: First, the stock should be issued by a public company not conducting business activities involving speculation, gambling, bribery, and other potentially sinful issues; second, the issuer should not have excessive financial leverage and should have over 90% of total revenues attributed to Islamic incomes. Refer to the official website of the IDX for more information: https://www.idx.co.id/en/idx-islamic/islamic-product/.

JKP propose a Bayesian learning framework to assess the replicability and robustness of factors. Specifically, they propose a hierarchical structure to model various factors that explain the correlations between factors and investors' learning about alphas. We modify their multilevel Bayesian model to identify the relevant risk factors in the Indonesian stock market.

Let f^i denote a factor. Under the CAPM, return on the factor in a month t is modelled as

$$f_t^i = \alpha^i + \beta^i r_t^m + \epsilon_t^i, \quad (1)$$

where r_t^m is the market portfolio return in month t, β^i is the factor's exposure to market risk, and ϵ_t^i is the factor residual return. The factor's alpha relative to the CAPM, α^i, can be decomposed in the following way,

$$\alpha^i = c^j + w^i, \quad (2)$$

where $c^j \sim N(0, \tau_c^2)$ represents alpha specific to the cluster j that the factor i belongs to, and $w^i \sim N(0, \tau_w^2)$ stands for the factor i's idiosyncratic alpha The hyperparameters τ_c^2 and τ_w^2 capture cross-cluster and idiosyncratic variations in factor alphas.

Suppose that there are K factors that classify into J clusters during a full sample period of T months. Eq. (2) can be expressed in the following vector form,

$$\alpha = Mc + w, \quad (3)$$

where $\alpha = (\alpha^1, \dots, \alpha^K)', c = (c^1, \dots, c^J)'$ and $w = (w^1, \dots, w^K)'$. M is a $K \times J$ cluster membership matrix, with $M_{ij} = 1$ if a factor i belongs to a cluster j and equals zero otherwise. The prior variance of alpha is given by

$$\Omega = MM'\tau_c^2 + I\tau_w^2, \quad (4)$$

where I is a K-dimensional identity matrix.

An investor can estimate the vector of alphas, $\hat{\alpha}$, from observed market data. Based on historical data, they update beliefs about the distributions of factor alphas. The posterior of the vector of factor alphas is normally distributed with a posterior mean of

$$E(\alpha|\hat{\alpha}) = (\Omega^{-1} + T\Sigma^{-1})^{-1} T\Sigma^{-1}\hat{\alpha}\,, \tag{5}$$

and a posterior variance of

$$Var(\alpha|\hat{\alpha}) = (\Omega^{-1} + T\Sigma^{-1})^{-1}, \tag{6}$$

where $\Sigma = \mathrm{Var}(\epsilon)$ is the variance matrix of factor residual returns.

4.2 Portfolio sorting with Main board breakpoints

We perform an empirical Bayesian (EB) analysis to test 152 prominent factors in the Indonesian stock market. At the end of each month t, individual stocks are sorted into quintile portfolios by a particular firm characteristic i based on breakpoints of Main board stocks. We then calculate the value-weighted (VW) excess return for each quantile portfolio p for the subsequent month $t+1$. A factor related to the firm characteristic c in month $t+1$ (f^{i}_{t+1}) is then defined as the difference between returns of portfolio 5 and 1 with the highest and lowest value of the firm characteristic.[3] The factors are signed so that the expected return of the factor is positive. [4] We then estimate a full sample ordinary least squares (OLS) regression to calculate a long-short portfolio alpha relative to the CAPM, $\hat{\alpha}^{i,\mathrm{OLS}}$, by regressing factor returns on a constant and contemporaneous market portfolio return.[5] Long-short portfolio alphas are scaled by $10\%/\sqrt{12}$ that each factor has a monthly idiosyncratic volatility of 10%. This treatment ensures that each factor has similar information ratio to facilitate comparison across factors.

We then follow the JKP methodology to perform EB analysis to obtain the posterior distribution of alpha for each factor i, $\hat{\alpha}^{i,\mathrm{EB}}$. First, a bootstrap sampling is used to estimate the

[3] To construct a valid factor, we require at least five individual stocks in both the long and short leg portfolio. A factor should have at least 60 monthly observations to be included.
[4] For example, stocks with higher annual asset growth rate earn lower average returns in the U.S. market. The high-minus-low portfolio return is multiplied by -1 so that the average return spread is average return on portfolio with the lowest asset growth rate minus average return of the portfolio with the highest asset growth rate.
[5] The market portfolio return is a value-weighted return on all stocks in the sample.

variance and covariance matrix of error terms, $\hat{\Sigma}$. Second, the 152 individual factors are clustered into 13 themes based on correlations between them. Appendix A lists the names of factors and the clusters in which they belong to. Third, given $\hat{\Sigma}$ and the cluster membership M, hyperparameters τ_c^2 and τ_w^2 are estimated under the maximum likelihood estimation (MLE). Finally, we compute posterior EB alphas and the variance of alphas. Estimated hyperparameters are reported in Table A1 of Appendix B.

Table 3 tabulates the results of the EB analysis using breakpoints based on Main board stocks. Panel A focuses on 117 factors that are statistically significant (at the 5% significance level) in the original studies. For each factor group, we report the number of variables that fall into that group, the number and fraction of factors with significant posterior alphas, and the average values of significant posterior factor alphas. Figure 2 plots the replication rate of each factor cluster. The detailed posterior alphas and their 95% confidence intervals for each individual factor are shown in Figure 3.

[Insert Table 3 here]

[Insert Figure 2 here]

[Insert Figure 3 here]

After accounting for the correlation between factors and investor learning, 41 of the 117 significant factors (35%) documented in previous studies remain statistically significant at the conventional level of significance of 5% in the Indonesian market. The value factor is the most robust, with a 100% replication rate and the largest magnitude of average posterior alphas (0.37%). Quality, profitability, and size clusters also have replication rates higher than 50% (83%, 70%, and 75%, respectively), with mean EB alphas of 0.26%, 0.24% and 0.28%. Only 3 of 19 factors in the investment cluster survive the EB analysis. Several factors related to profit growth and seasonality also earn significant posterior alphas, but the replication rates are lower than 30% for the two clusters (29% and 10%, respectively).

Short-term reversal and price momentum do not exist in the Indonesian market. None of the four factors related to short term reversal nor the eight factors related to momentum earn significant EB alphas in our sample. We find no strong evidence for accrual anomalies, low leverage puzzles, or low risk puzzles among IDX stocks. Debt issuance factors do not appear to affect cross-sectional Indonesian stock returns either.

We report the OLS results for comparison. Adopting the EB framework does not reduce the number of significant factors, yet posterior factor alphas tend to shrink towards zero. The effect of the EB method differs between factor clusters. For example, the number of significant value factors increases from 9 to 15 after adjusting for investors' learning about factors. In contrast, the single significant investment factor (inventory growth) under OLS becomes insignificant using the EB method.

As a robustness check, we repeat the analysis using all 152 factors.[6] The results are reported in Panel B of Table 3. Including the full set of factors does not change our inferences. The value cluster remains the most robust category under the EB method, followed by the quality, size, and profitability factors. We still detect no momentum or short-term reversal in Indonesian stock returns.

Overall, the multilevel EB analysis reveals that value, quality, size, and profitability factors are the most relevant factors in the Indonesian stock market. The results are robust to the inclusion or exclusion of factors that are insignificant in the original markets where the factors were first proposed.

4.3 Portfolio sorting with NYSE non-micro stock breakpoints

[6] In a later section we conduct EB analysis separately for the Sharia and non-Sharia sample. Three out of the 152 factors drop out as there are not enough sample to perform the portfolio sorting separately for subsamples.

Indonesia's stock market has been open to foreign investors as the Indonesia government has implemented a series of policies to reform the country's economy. The high expected growth of the Indonesia capital market and the benefits of global diversification have attracted foreign investments in the emerging market. The average foreign institutional ownership of IDX stocks amounts to 4.79%. It is also important to consider the trading strategy from the point of view of foreign investors. We assume that foreign investors may use a more universal reference when making investment decisions. Following Fama and French (2015), we use breakpoints of non-micro stocks listed on the NYSE, which are the top 80% stocks in terms of market capitalization. Prices and values of financial statement items of Indonesian stocks are converted into $USD using exchange rates obtained from Compustat.

[Insert Table 4 here]

[Insert Figure 4 here]

[Insert Figure 5 here]

Table 4 tabulates the number and fraction of replicable factors and average factor alphas under EB and OLS for each factor theme under NYSE non-micro breakpoints. We focus on factors significant in the original markets (typically the US market). Figure 4 illustrates the replication rate of the factors in each group. Figure 5 provides detailed EB alphas for each factor, along with the posterior 95% confidence interval.

Under the NYSE non-micro breakpoints, factors in some clusters deliver performance similar to their counterparts when IDX main board breakpoints are used. From the point of view of international institutional investors, value factors are also the most profitable and replicable factors. 11 of the 12 value factors (replication rate = 91.67%) earn significant posterior alphas with an average value of 0.42% on the Indonesian market. The strong performance of the quality and profitability factors from the perspective of domestic investors extends to international investors. Six out of 10 factors in the profitability cluster (replication

rate = 60.00%) and seven out of 12 factors in the quality cluster (replication rate = 58.33%) earn significant EB alphas, with a mean value of 0.27% and 0.29%, respectively. Long-short strategies based on variables related to firm investment are not statistically significant in most cases, with a low replication rate of 21.05%. Factors in the accrual, low leverage, low risk, profit growth, seasonality, or short-term reversal clusters have lower than 20% replication rates.

We also document changes in factor performance when NYSE non-micro breakpoints are used. In particular, the prominent size effect for local investors loses importance for international investors. Only one of the four size factors remain statistically significant posteriorly. The result can be attributed to the small market capitalization of IDX stocks: about 80% of Indonesian stocks are micro stocks according to the NYSE criteria. Even relatively large IDX stocks in view of local investors count as small stocks based on the NYSE criteria. Contrary to their low replication rate by IDX breakpoints, factors related to debt issuance can be replicated in 80% cases when NYSE non-micro breakpoints are used. Another salient difference is the momentum effect. Four out of the eight significant momentum factors earn significant EB alphas if IDX stocks are sorted by NYSE breakpoints. The results indicate that the prominent and highly profitable momentum strategy in the United States and several developed countries can also generate high profits for institutional investors who participate in the Indonesia market.

We also examine factors based on non-micro stocks on the NYSE under the conventional OLS framework to look at the impacts of EB on factor performance. Accounting for investors' learning about factors and cluster-specific factors reduces the number of significant factors and the magnitudes of factor alphas. It appears that the influence of EB is more pronounced for sorting by NYSE non-micro breakpoints than for sorting by IDX main board breakpoints.

To sum up, we use NYSE non-micro breakpoints to construct stock factors and seek to explore the cross-section of Indonesia stock returns through the lens of foreign institutional

investors. With this sorting method, we still find considerable significant factors, both in quantity and magnitude. Value, quality, and profitability factors remain as replicable and profitability factors. Yet, the size effect loses significance to a large extent. We also find that debt issuance and momentum factors are quite essential determinants of Indonesian cross-sectional stock returns when NYSE non-micro breakpoints are used.

5. Additional Analysis and Robustness Checks

5.1 Subsample analysis: Sharia and non-Sharia stocks

Indonesia has the single largest population of Muslims, with more than 85% of its population identifying as Muslims. In total, it hosts 13% of the Muslim population in the world. A stock is classified as a 'Sharia stock' by the IDX if it meets certain requirements that are in accordance with Islamic principles. Stocks not satisfying the religious requirements are 'non-Sharia' stocks. If local investors with Islamic beliefs have preference for Sharia stocks adhering to Islamic principles, it should affect their investment decisions in a systematic way. In turn, the equilibrium price of Indonesian stocks will be affected by such preference. In this section, we separately analyze Sharia and non-Sharia stocks. The results can reveal potential differences in the pricing mechanism between the two types of securities.

[Insert Table 5 here]

[Insert Figure 6 here]

[Insert Figure 7 here]

Panel A of Table 5 tabulates results of long-short portfolios sorted by IDX Main board breakpoints for the two types of IDX stocks. Figure 6 shows replication rates by clusters of factors of Sharia and non-Sharia stocks. Figure 7 illustrates detailed posterior alphas and the corresponding 95% confidence intervals of individual Sharia and non-Sharia factors. We focus on the significant factors in the original studies. Overall, factors constructed from non-Sharia

stocks have a higher replication rate and EB alphas of greater magnitudes than factors constructed from Sharia stocks. Factor performance among Sharia and non-Sharia stocks shares similarity but exhibits differences in some cases. For both types of stocks, the value and size factors earn significant EB alphas. The value cluster is the most replicable theme for both Sharia stocks (replication rate = 100%) and non-Sharia stocks (replication rate = 86.67%). Size factors rank as the second replicable factors for Sharia stocks (75%, 3 out of 4) and take the fourth place for non-Sharia stocks (50%, 2 out of 4). Except for the value and size themes, some factors in the profit growth, investment, and seasonality clusters are also replicable among Sharia stocks, although the replication rates are lower than 30%. The superior performance of profitability and quality factors can be traced to the non-Sharia sample. For non-Sharia stocks, 70% profitability (7 out of 10) and 66.67% quality factors (8 out of 12) have significant posterior alphas. One out of the eight momentum trading strategies in the non-Sharia stocks generates significant posterior anormal returns. The magnitudes of EB alphas of factors constructed from non-Sharia stocks overall exceed counterparts of Sharia stocks. We also notice that Bayesian updating appears to exert larger influences on non-Sharia factors than on Sharia factors. Using the EB framework reduces the overall replication rate of non-Sharia factors slightly from 29% to 27%, whereas the replication rate of Sharia factors increases after the EB treatment.

Over the past several decades, there has been a trend for ethical and responsible investments for global investors. International investors can very well take into account the religious attributes of Indonesian stocks when trading IDX stocks. We also evaluate factor performance of Sharia and non-Sharia stocks from the view of foreign institutional investors who may form portfolios by NYSE non-micro breakpoints. The results are reported in panel B of Table 5. Contrary to the results for local investors, more factors are significant when constructed from Sharia stocks. Ten factors of non-Sharia stocks earn significant posterior

abnormal returns, whereas Sharia stocks have 17 significant factors under the EB method. However, average magnitudes of significant EB alphas are sizable for the non-Sharia subsample. For both Sharia and non-Sharia stocks, none of the 13 clusters of factors are robust to the EB structure in more than 50% cases. The best performing factors come from the value cluster. For both types of IDX stocks, five out of the 12 value factors earn significant EB alphas, with an average magnitude of 0.28% for Sharia stocks and 0.44% for non-Sharia stocks.

In summary, we do find that the religious attributes of Indonesian stocks have implications on pricing factors in the emerging capital market, and the implications appear to differ for local and international investors. For local investors, the non-Sharia factors are more significant and profitable. The overall good performance of profitability and quality factors can be traced back to non-Sharia stocks. For international institutional investors, there are more incidences of significant factors in the Sharia sample. Value factors are the most robust and profitable for both sub-samples of IDX stocks. The differences in factors for Sharia and non-Sharia stocks in the lens of local and international investors suggest that they may have different mindsets when evaluating financial securities associated with religious beliefs.

5.2 Portfolio sorting using total IDX breakpoints

In the main empirical analysis, we use breakpoints of stocks listed on the IDX Main board to sort portfolios, which are more mature stocks with less noisy signals in firm fundamentals and market pricing information. The Indonesian market is populated by young investors who may lack financial knowledge. When making investment decisions, naïve investors may ignore the noise in information and compare individual stocks with the entire universe of available stocks. As a robustness check for Indonesian factors through the lens of local investors, we use all IDX stocks to identify quintile breakpoints and construct factors based on the corresponding characteristics. The results of the IDX portfolio sorting all breakpoints by a factor theme are

reported in Table A2 in Appendix B. Replication rates of the 13 factor clusters and posterior alphas of individual factors under all breakpoints are illustrated in Figures A1 and 2 in Appendix B. We focus on the significant factors in the original studies.

Using IDX all breakpoints to sort portfolios, the overall replication rate of factors under the EB and OLS is 33.90% and 27.97%, slightly higher than the corresponding values when IDX Main board breakpoints are used. In general, the significant factor themes are similar to those using Main board breakpoints. Factors in the value, size, and quality clusters are 100% replicable after EB adjustments, with an average EB alpha of 0.37%, 0.26%, and 0.26%. Six out of 10 profitability earns significant EB alphas with an average magnitude of 0.26%. Other factor themes have replication rates lower than 50%. The weak short-term reversal and momentum effects are robust to the alternative method for sorting IDX stocks.

6. Conclusion

The last three decades have witnessed a rapidly growing and developing capital market in Indonesia. However, academic research on the Indonesian stock market is scarce. We explore the relevant risk factors in the Indonesian stock market.

We sort individual stocks into quintiles by a rich set of firm characteristics documented by prior studies to affect cross-sectional expected stock returns using breakpoints of IDX mainboard stocks for domestic investors and of NYSE non-micro stocks for international investors. We assess factor performance by the empirical hierarchical Bayesian updating framework recently proposed by Jensen, Kelly, and Pedersen (2023), which accounts for correlations between factors and investors' learning about factors as times passes. For domestic investors, 41 of 117 factors produce significant alphas in the Indonesia market after EB adjustments. Value, quality, size, and profitability themes are relevant in explaining cross-sectional IDX stock returns. For international investors, 37 out of 114 significant factors earn

significant posterior alphas in the Indonesian market, and the value factor is the most robust and profitable.

In view of the large Muslim population in Indonesia and recent trends in the global market for ethical and responsible investments, we test whether investors account for religious attributes of IDX stocks in a way that affects their investment decisions and stock pricing. We document differences in factors between Sharia stocks adhering to Islamic principles and non-Sharia stocks not fully abiding by Islamic laws. For local investors, factors earn more significant and sizable EB abnormal returns among non-Sharia stocks. Quality and profitability factors have high replication rates for the non-Sharia subsample, but not for the Sharia sample. For international investors, Sharia factors have higher replication rates than non-Sharia factors. The value factor is the most profitable for both subsamples. The differences in Sharia and non-Sharia factors indicate that investors do pay attention to religious attributes of IDX stocks, and local and foreign investors appear to hold different views on the religious attributes.

The results of this paper shed light on the determinants of cross-sectional returns on stocks listed on the Indonesian stock market. We contribute to the extensive literature about cross-sectional stock returns by testing prominent factors in a newly emerging market. Although we document several robust and significant factors documented by extant studies on the Indonesian stock market, the overall replication rate is lower than 40%. It seems that a large faction of cross-section IDX stock returns remains unexplained by factors discovered in developed regions.

The underlying reasons behind the significance of the relevant factors in the Indonesian market are still undetermined. We suspect that they could be different from those in the more developed markets. It is possible that market frictions or behavioral biases exert larger influences on cross-sectional stock returns in this retail dominated market. We leave the possibility for future research.

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Table 1: Market capitalization and trading volume of IDX by year

The table shows number of unique stocks (#stocks), total dollar trading volume (in $USD million), and year-end total market capitalization of common shares (in $USD million) listed on the Indonesia Stock Exchange (IDX) for each year from 1991 to 2022.

Year	#Stocks	Market Cap	Dollar Trading Volume
1991	137	7,370.38	1.08
1992	151	10,985.46	0.54
1993	160	29,428.01	0.23
1994	185	40,358.08	0.21
1995	229	66,438.89	605.74
1996	249	90,350.32	1,602.30
1997	265	29,277.81	1,095.70
1998	285	21,169.02	430.49
1999	279	45,406.52	1,953.65
2000	264	22,191.18	471.29
2001	284	19,804.68	472.32
2002	301	28,368.21	996.40
2003	318	52,158.04	1,552.87
2004	326	72,418.70	2,604.47
2005	324	81,104.77	1,718.78
2006	329	136,846.71	4,036.32
2007	352	211,920.79	7,284.98
2008	364	96,669.41	2,469.72
2009	368	212,023.47	4,571.00
2010	391	360,950.19	8,704.37
2011	420	390,192.96	6,174.31
2012	443	429,314.49	7,581.16
2013	475	348,501.64	5,237.21
2014	491	419,447.83	7,053.55
2015	508	353,268.71	4,447.68
2016	517	424,637.98	6,848.89
2017	555	515,763.26	6,857.75
2018	605	482,027.61	7,809.99
2019	659	521,716.15	7,139.40
2020	695	496,099.81	21,761.98
2021	731	579,953.30	15,479.75
2022	784	612,161.79	12,790.10

Table 2: Summary statistics of returns and characteristics of IDX stocks

The table tabulates descriptive statistics and correlation matrix for stocks listed on the IDX. Panel A reports summary statistics for the full sample. Mean is the average value. Std Dev is standard deviation. p10, p25, p50, p75, p90 are the 10th, 25th, 50th, 75th and 90th percentiles. Ret is monthly return (in percentage). ExRet is monthly return in excess of the risk-free rate (in percentage). Volatility is standard deviation of monthly return (in percentage). Trading volume is total trading volume in a month. Beta is market beta estimated using monthly returns in the previous 2 to 5 years (as available). BM is book-to-market ratio. Age is the number of months since firm inception date. GP/AT is gross profits scaled by total assets. ATG is annual change in book value of total assets. IO is percentage of institutional ownership out of total shares outstanding. IO_Domestic and IO_Foreign are the percentage of shares held by domestic and foreign institutional investors. Panel B reports mean value of variables of stocks grouped by market capitalization, listing boards and religious property. Proportion (%) is the percentage of stocks falling into a group out of the total sample. For NYSE size breakpoints, mega, large, small, micro and nano stocks are stocks with market capitalization greater than 80th percentile, between 50th and 80th percentile, between 20th and 50th percentile, between 1st and 20th percentile, and lower than 1st percentile of NYSE stocks. For IDX size breakpoints, mega, large, middle, small and micro stocks are stocks with market capitalization greater than 90th percentile, between 60th and 90th percentile, between 40th and 60th percentile, between 20th and 40th percentile, and lower than 20th percentile of IDX Main board stocks. (Non-)Sharia stocks are stocks issued by firms adhering to (violating) Islamic principles. Panel C reports matrix for pairwise correlation coefficients between key variables.

Panel A: Summary statistic of the full sample

Variable	Mean	Std Dev	p10	p25	p50	p75	p90
Ret	1.86	39.03	-17.15	-7.49	-0.45	6.83	20.35
ExRet	1.72	39.03	-17.33	-7.62	-0.58	6.71	20.21
Volatility	0.17	0.13	0.06	0.09	0.13	0.21	0.33
Beta	1.01	0.52	0.40	0.68	0.99	1.32	1.67
Age	286.30	124.88	102.00	181.00	305.00	397.00	442.00
BM	1.42	2.54	0.20	0.40	0.83	1.58	2.94
Size	616.55	2,615.07	5.24	15.63	64.20	284.20	1,085.91
Trading volume	232.89	1,415.13	0.03	0.36	6.36	80.81	426.07
GPAT	0.23	0.22	0.05	0.11	0.19	0.30	0.46
ATG	1.09	31.40	-0.17	-0.05	0.05	0.19	0.43
IO	5.06	6.92	0.06	0.51	2.60	7.30	13.61
IO_FOR	4.79	6.57	0.05	0.45	2.42	6.85	12.88
IO_DOM	0.27	1.84	0.00	0.00	0.00	0.11	0.71

Panel B: Mean values of firm characteristics by size, listing board and religious attribute

Group	Proportion (%)	*Ret*	*ExRet*	*Volatility*	*Beta*	*Age*	*BM*	*Size*	*Trading volume*	*GP/AT*	*ATG*
By NYSE size group											
Mega	1.11	1.86	1.76	0.10	1.01	342.18	0.25	19991.12	794.92	0.50	0.17
Large	4.43	2.38	2.25	0.12	1.06	322.67	0.38	4012.84	416.41	0.32	0.19
Small	12.65	2.40	2.27	0.14	1.08	311.86	0.60	983.21	557.51	0.26	1.03
Micro	39.66	2.21	2.06	0.16	1.01	287.50	1.10	165.52	257.21	0.23	1.49
Nano	38.57	1.26	1.12	0.21	0.99	270.69	2.23	17.42	74.99	0.19	0.85
By IDX Main board size group											
Mega	5.23	2.23	2.09	0.12	1.05	323.22	0.37	7499.23	518.10	0.35	0.17
Large	19.60	2.65	2.51	0.15	1.10	302.58	0.76	842.44	483.87	0.26	1.05
Small	17.24	2.16	2.01	0.16	1.04	289.14	1.06	205.54	298.29	0.26	2.28
Micro	20.62	2.54	2.39	0.18	1.01	278.71	1.42	74.50	139.73	0.21	0.94
Nano	36.70	0.86	0.72	0.21	0.94	275.06	2.18	17.42	83.68	0.19	0.79
By listing board											
Main	54.94	1.83	1.70	0.15	1.06	312.68	1.32	1098.75	227.51	0.26	0.63
Development	44.19	1.86	1.73	0.20	0.92	272.58	1.46	154.64	270.23	0.20	1.67
Acceleration	0.28	-0.69	-0.77	0.18	.	138.27	0.63	13.68	177.54	0.19	2.59
By adherence to Sharia law											
Sharia stocks	53.38	1.93	1.80	0.16	1.02	299.49	1.42	552.38	185.66	0.25	0.66
Non-Sharia stocks	46.62	1.77	1.62	0.18	1.00	270.03	1.42	695.99	292.23	0.19	1.65

Panel C: Correlation matrix

	Ret	*Volatility*	*Beta*	*Age*	*BM*	*lnSize*	*Trading Volume*	*GP/AT*	*ATG*
Ret	1.00	0.14	0.03	0.00	0.02	0.00	0.02	0.01	0.00
Volatility		1.00	0.06	-0.22	-0.33	-0.13	0.05	-0.14	0.00
Beta			1.00	-0.09	0.02	0.01	0.10	-0.07	0.01
Age				1.00	0.28	0.13	0.03	0.09	-0.03
BM					1.00	0.47	0.13	0.19	0.00
lnSize						1.00	0.07	0.18	0.00
Trading Volume							1.00	-0.06	0.00
GP/AT								1.00	-0.01
ATG									1.00

Table 3: Factors of the IDX using main board stock breakpoints

Stocks are sorted into quintiles by firm characteristics. We use breakpoints of stocks listed on the IDX Main board to sort portfolios. Factors are clustered into 13 themes. #Var is the number of variables in each cluster. #Sig is the number of significant factors in the Indonesia market under the empirical Bayesian (EB) and OLS framework. $\bar{\alpha}^{\mathrm{EB}}$ and $\bar{\alpha}^{\mathrm{OLS}}$ are average values of posterior alpha and OLS alpha of significant factors under the EB and OLS methods, respectively. Factor RR% is the replication rate, defined as the number of factors significant in the IDX out of the number of factors significant in the original studies. Mean value of alphas and replication rates are reported in percentage. Panel A reports results of 117 factors significant in the original studies. Panel B reports results for all 149 factors (3 of the 152 factors lack sufficient data for analysis). The sample period is from January 2001 throughout December 2022.

Panel A: Factors significant in the original studies

		EB			OLS		
Cluster	#Var	#Sig	RR%	$\bar{\alpha}^{\mathrm{EB}}$	#Sig	RR%	$\bar{\alpha}^{\mathrm{OLS}}$
Accruals	6	.	.	.	.	.	.
Debt Issuance	5	.	.	.	1	20%	0.37
Investment	19	3	16%	0.23	4	21%	0.40
Low Leverage	4	.	.	.	.	.	.
Low Risk	13	.	.	.	.	.	.
Momentum	8	.	.	.	.	.	.
Profit Growth	7	2	29%	0.24	2	29%	0.45
Profitability	10	7	70%	0.24	5	50%	0.40
Quality	12	10	83%	0.26	8	67%	0.42
Seasonality	10	1	10%	0.17	2	20%	0.39
Short-Term Reversal	4	.	.	.	.	.	.
Size	4	3	75%	0.28	1	25%	0.49
Value	15	15	100%	0.37	9	60%	0.51
Total	117	41	35.04%		32	27.35%	

Panel B: All factors

		EB			OLS		
Cluster	#Var	#Sig	RR%	$\bar{\alpha}^{\mathrm{EB}}$	#Sig	RR%	$\bar{\alpha}^{\mathrm{OLS}}$
Accruals	6	.	.	.	.	.	.
Debt Issuance	7	.	.	.	1	14%	0.37
Investment	22	3	14%	0.23	4	18%	0.40
Low Leverage	9	.	.	.	.	.	.
Low Risk	18	.	.	.	.	.	.
Momentum	8	.	.	.	.	.	.
Profit Growth	12	4	33%	0.25	4	33%	0.56
Profitability	11	8	73%	0.24	5	46%	0.40
Quality	17	14	82%	0.25	9	53%	0.42
Seasonality	12	1	8%	0.17	2	17%	0.39
Short-Term Reversal	6	.	.	.	.	.	.
Size	4	3	75%	0.28	1	25%	0.49
Value	17	17	100%	0.37	10	59%	0.50
Total	149	50	33.56%		36	24.16%	

Table 4: Factors of the IDX using NYSE non-micro breakpoints
Stocks are sorted into quintiles by firm characteristics with significant predictive power for future stock returns documented in the original markets where factors are first proposed. We use breakpoints of stocks listed on the NYSE with market capitalization greater than 20th percentile of firm size for NYSE stocks in each month to sort portfolios. Factors are clustered into 13 themes. #Var is the number of variables in each cluster. #Sig is the number of significant factors in the Indonesia market under the empirical Bayesian (EB) and OLS framework. $\overline{\alpha}^{EB}$ and $\overline{\alpha}^{OLS}$ are average values of posterior alpha and OLS alpha of significant factors under the EB and OLS methods, respectively. Factor RR is replication rate, defined as the number of factors significant in the IDX out of the number of factors significant in the original studies. Mean value of alphas and replication rates are reported in percentage. The sample period is from January 2001 throughout December 2022.

		EB			OLS		
Cluster	#Var	#Sig	RR%	$\bar{\alpha}^{EB}$	#Sig	RR%	$\bar{\alpha}^{OLS}$
Accruals	6	.	.	0.28	.	.	0.42
Debt Issuance	5	4	80%	0.28	4	80%	0.41
Investment	19	4	21%	.	4	21%	.
Low Leverage	4	.	.	.	.	.	0.44
Low Risk	13	.	.	0.29	2	15%	0.39
Momentum	8	4	50%	0.30	4	50%	0.56
Profit Growth	7	2	29%	0.27	2	29%	0.44
Profitability	10	6	60%	0.29	6	60%	0.44
Quality	12	7	58%	.	9	75%	0.32
Seasonality	10	.	.	.	2	20%	.
Short-Term Reversal	4	.	.	0.27	.	.	0.39
Size	4	1	25%	0.42	1	25%	0.56
Value	12	11	92%	0.00	9	75%	0.00
Total	114	39	34%	0.00	43	38%	0.00

Table 5: Factors of the IDX for Sharia and non-Sharia stocks

The table reports EB and OLS alphas of factors constructed from long-short portfolios of Sharia and non-Sharia stocks sorted by firm characteristics with significant predictive power for future stock returns as in prior literature. Sharia stocks are stocks adhering to Islamic principles and non-Sharia stocks are stocks not meeting the Sharia stock criteria. Panel A uses breakpoints of stocks listed on the IDX Main board to sort portfolios. Panel B uses NYSE non-micro breakpoints for portfolio sorting. Factors are clustered into 13 themes. #Var is the number of variables in each cluster. #Sig is the number of significant factors in the Indonesia market under the empirical Bayesian (EB) and OLS framework. $\bar{\alpha}^{\mathrm{EB}}$ and $\bar{\alpha}^{\mathrm{OLS}}$ are average values of posterior alpha and OLS alpha of significant factors under the EB and OLS methods, respectively. Factor RR is replication rate, defined as the number of factors significant in the IDX out of the number of factors significant in the original studies. Mean value of alphas and replication rates are reported in percentage. The sample period is from January 2001 throughout December 2022.

Panel A: Factors using IDX Main board breakpoints

		Sharia Stocks						non-Sharia Stocks					
		EB			OLS			EB			OLS		
Cluster	#Var	#Sig	RR%	$\bar{\alpha}^{\mathrm{EB}}$	#Sig	RR%	$\bar{\alpha}^{\mathrm{OLS}}$	#Sig	RR%	$\bar{\alpha}^{\mathrm{EB}}$	#Sig	RR%	$\bar{\alpha}^{\mathrm{OLS}}$
Accruals	6	.	.	.	1	17%	0.37	.	.	.	.	.	.
Debt Issuance	5	.	.	.	.	.	.	.	.	.	2	40%	0.36
Investment	19	2	11%	0.21	2	11%	0.41	.	.	.	1	5%	0.56
Low Leverage	4	.	.	.	.	.	.	.	.	.	.	.	.
Low Risk	13	.	.	.	1	8%	0.48	.	.	.	1	8%	0.34
Momentum	8	.	.	.	.	.	.	1	13%	0.25	3	38%	0.33
Profit Growth	7	2	29%	0.23	3	43%	0.52	.	.	.	1	14%	0.38
Profitability	10	.	.	.	.	.	.	7	70%	0.35	7	70%	0.53
Quality	12	.	.	.	1	8%	0.38	8	67%	0.27	8	67%	0.48
Seasonality	10	1	10%	0.17	2	20%	0.44	.	.	.	1	10%	0.38
Short-Term Reversal	4	.	.	.	.	.	.	.	.	.	.	.	.
Size	4	3	75%	0.22	1	25%	0.37	2	50%	0.31	2	50%	0.41
Value	15	15	100%	0.27	5	33%	0.55	13	87%	0.36	8	53%	0.52
Total	117	23	20%		16	14%		31	27%		34	29.06	

Table 5: Factors of the IDX for Sharia and non-Sharia stocks - Cont.

Panel B: Factors using NYSE non-micro breakpoints

	Sharia Stocks							non-Sharia Stocks					
		EB			OLS			EB			OLS		
Cluster	#Var	#Sig	RR%	$\bar{\alpha}^{EB}$	#Sig	RR%	$\bar{\alpha}^{OLS}$	#Sig	RR%	$\bar{\alpha}^{EB}$	#Sig	%RR	$\bar{\alpha}^{OLS}$
Accruals	6	.	.	.	.	.	.	.	.	.	1	17%	0.42
Debt Issuance	5	2	40%	0.27	3	60%	0.55	.	.	.	1	20%	0.38
Investment	19	4	21%	0.30	5	26%	0.46	.	.	.	4	21%	0.47
Low Leverage	4	.	.	.	.	.	.	.	.	.	1	25%	0.41
Low Risk	13	.	.	.	1	8%	0.40	.	.	.	1	8%	0.48
Momentum	8	1	13%	0.29	2	25%	0.43	3	38%	0.42	3	38%	0.59
Profit Growth	7	.	.	.	1	14%	0.55	.	.	.	1	14%	0.41
Profitability	10	.	.	.	1	10%	0.41	1	10%	0.31	5	50%	0.47
Quality	12	3	25%	0.27	4	33%	0.52	1	8%	0.30	5	42%	0.45
Seasonality	10	1	10%	0.28	2	20%	0.54	.	.	.	.	.	.
Short-Term Reversal	4	.	.	.	.	.	.	.	.	.	.	.	.
Size	4	1	25%	0.27	1	25%	0.48	.	.	.	.	.	.
Value	12	5	42%	0.28	5	42%	0.44	5	42%	0.44	5	42%	0.67
Total	114	17	15%		25	22%		10	9%		27	24%	

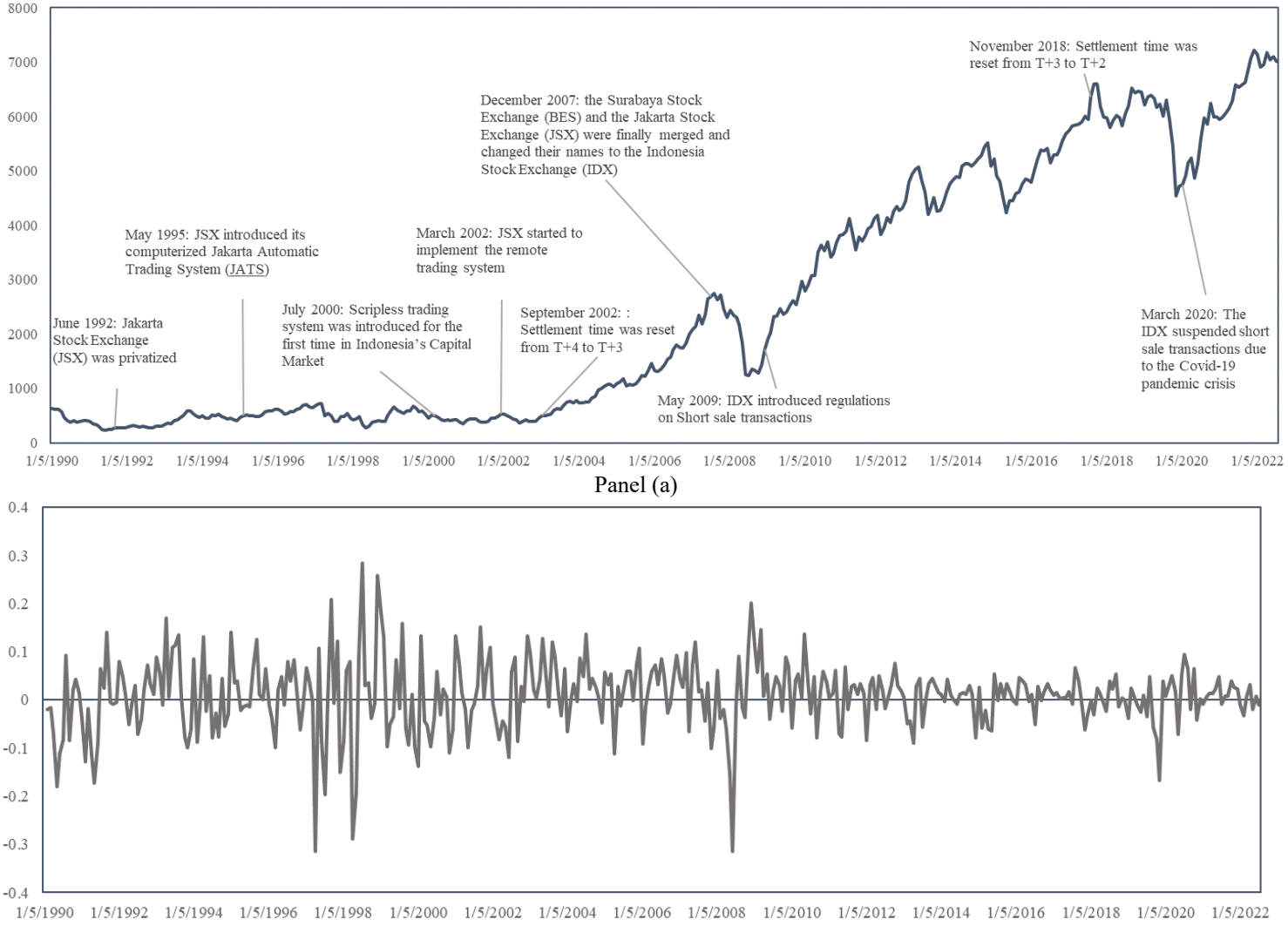
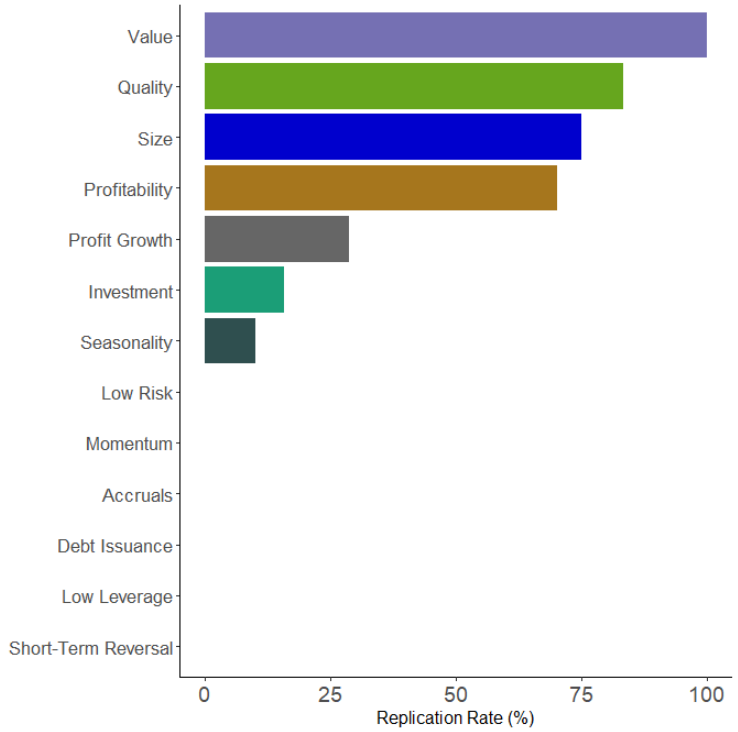
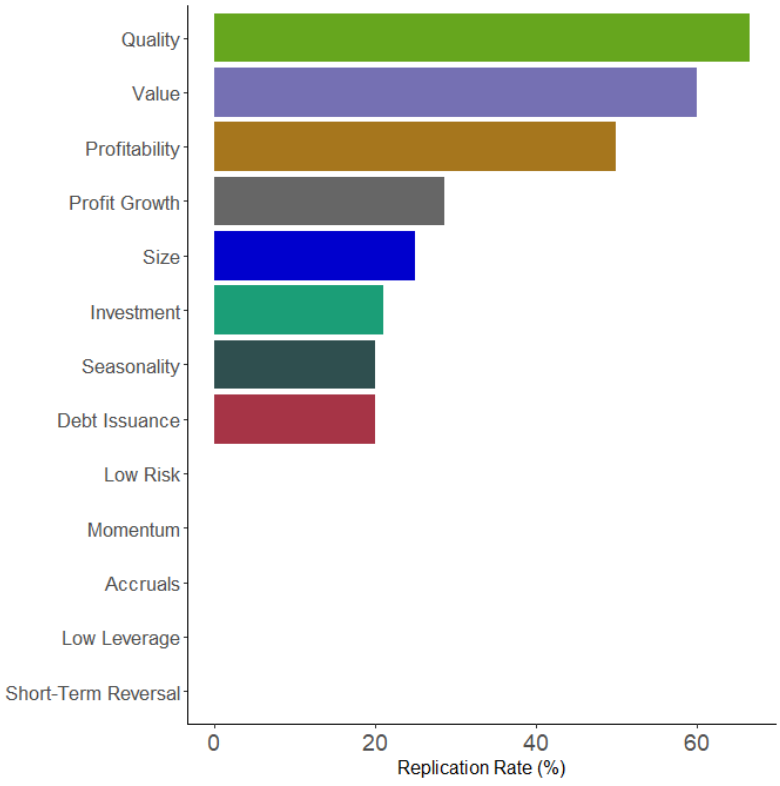


Figure 1: Time-series of level and return on the IDX Composite Index



(a) EB



(b) OLS

Figure 2: Replication rates by cluster with IDX Main board breakpoints
IDX stocks sorted into quintile portfolios by IDX Main board breakpoints of 117 firm characteristic with significant predictivity for future stock returns as in prior studies. The figure shows percentages of long-short portfolios with significant alphas under the EB (panel a) and the OLS (panel b) methods out of the number of factors in each cluster theme.

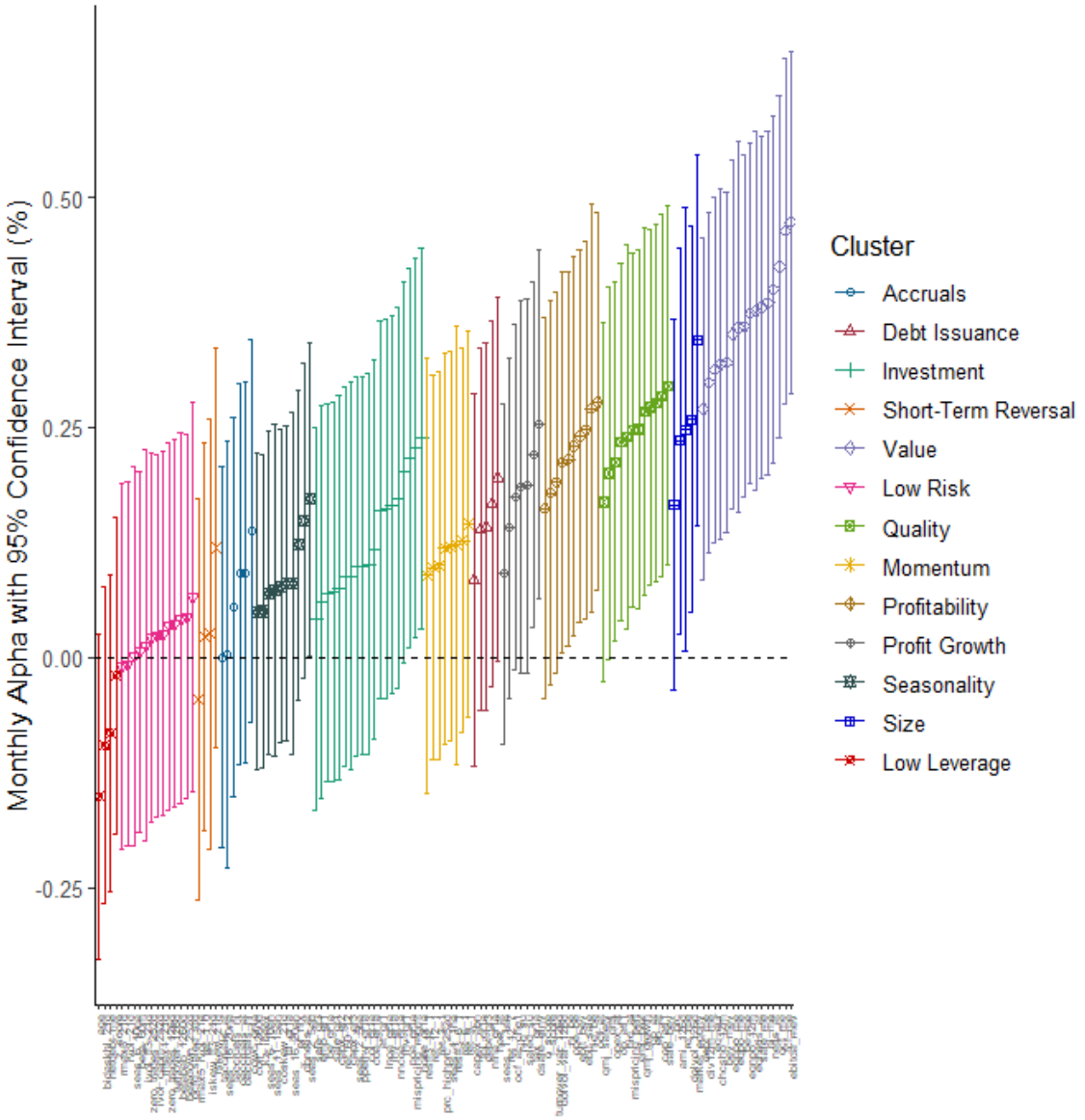
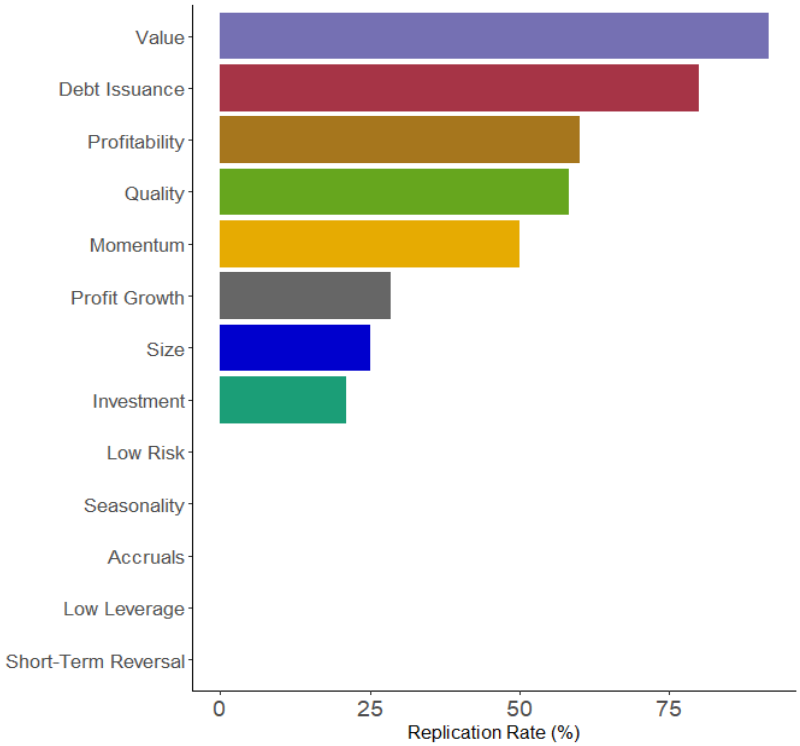
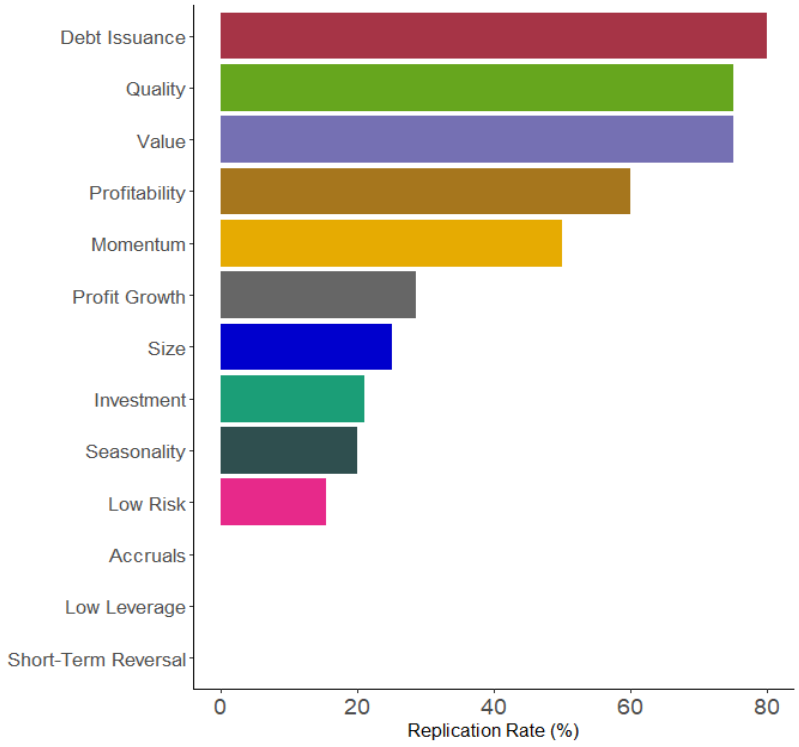


Figure 3: Average EB posterior alphas and confidence intervals of factors by cluster them with IDX Main board breakpoints

IDX stocks sorted into quintile portfolios by IDX Main board breakpoints of 117 firm characteristic with significant predictivity for future stock returns as in prior studies. The figure shows EB posterior alphas and associated 95% confidence internals of each factor clustered into 13 themes.



(a) EB



(b) OLS

Figure 4: Replication rates by cluster with NYSE non-micro breakpoints
IDX stocks sorted into quintile portfolios by NYSE non-micro breakpoints of 114 firm characteristic with significant predictivity for future stock returns as in prior studies. The figure shows percentages of long-short portfolios with significant alphas under the EB (panel a) and the OLS (panel b) methods out of the number of factors in each cluster theme.

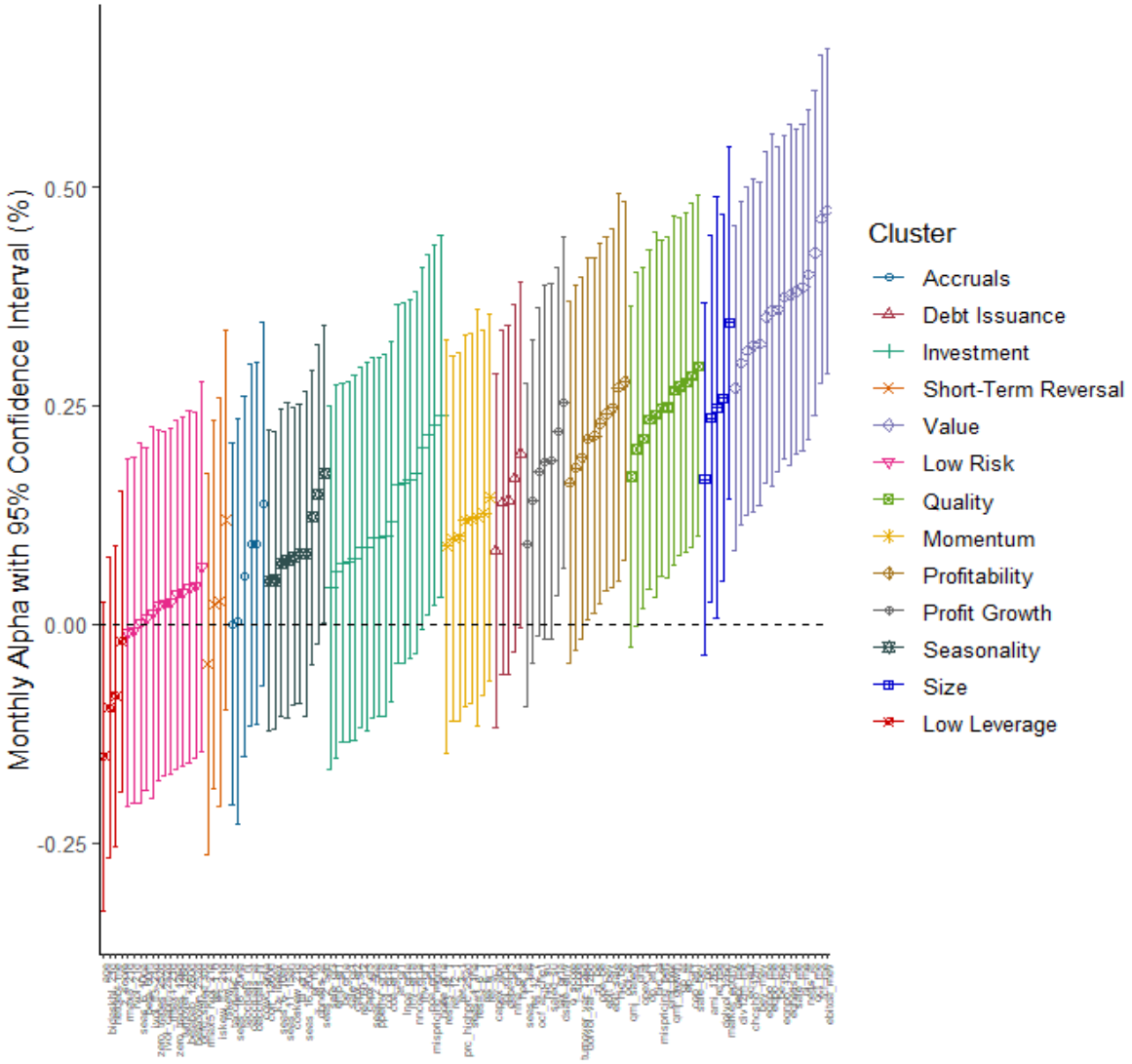
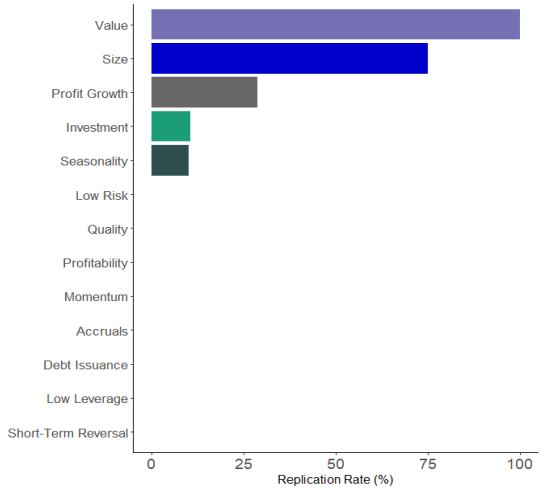
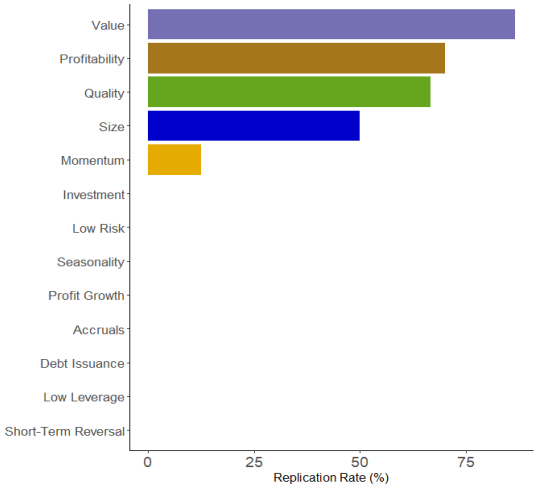


Figure 5: Average EB posterior alphas and confidence intervals of factors by cluster them with NYSE non-micro breakpoints

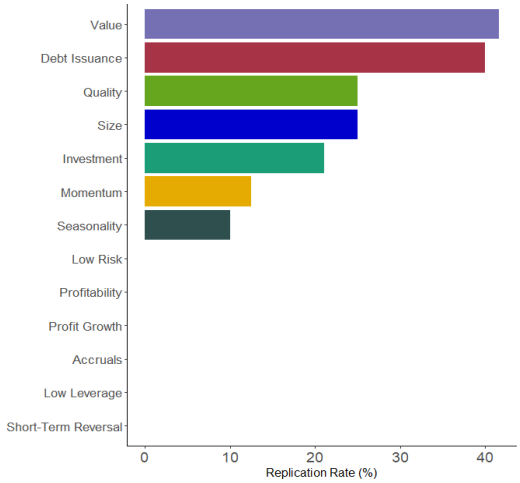
IDX stocks sorted into quintile portfolios by NYSE non-micro breakpoints of 117 firm characteristic with significant predictivity for future stock returns as in prior studies. The figure shows EB posterior alphas and associated 95% confidence internals of each factor clustered into 13 themes.



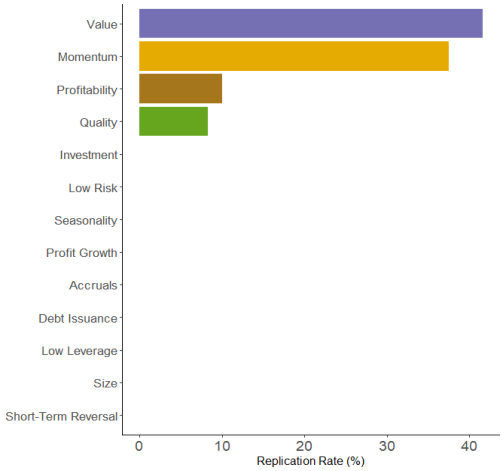
(a) IDX Main board, Sharia stocks



(b) IDX Main board, non-Sharia stocks

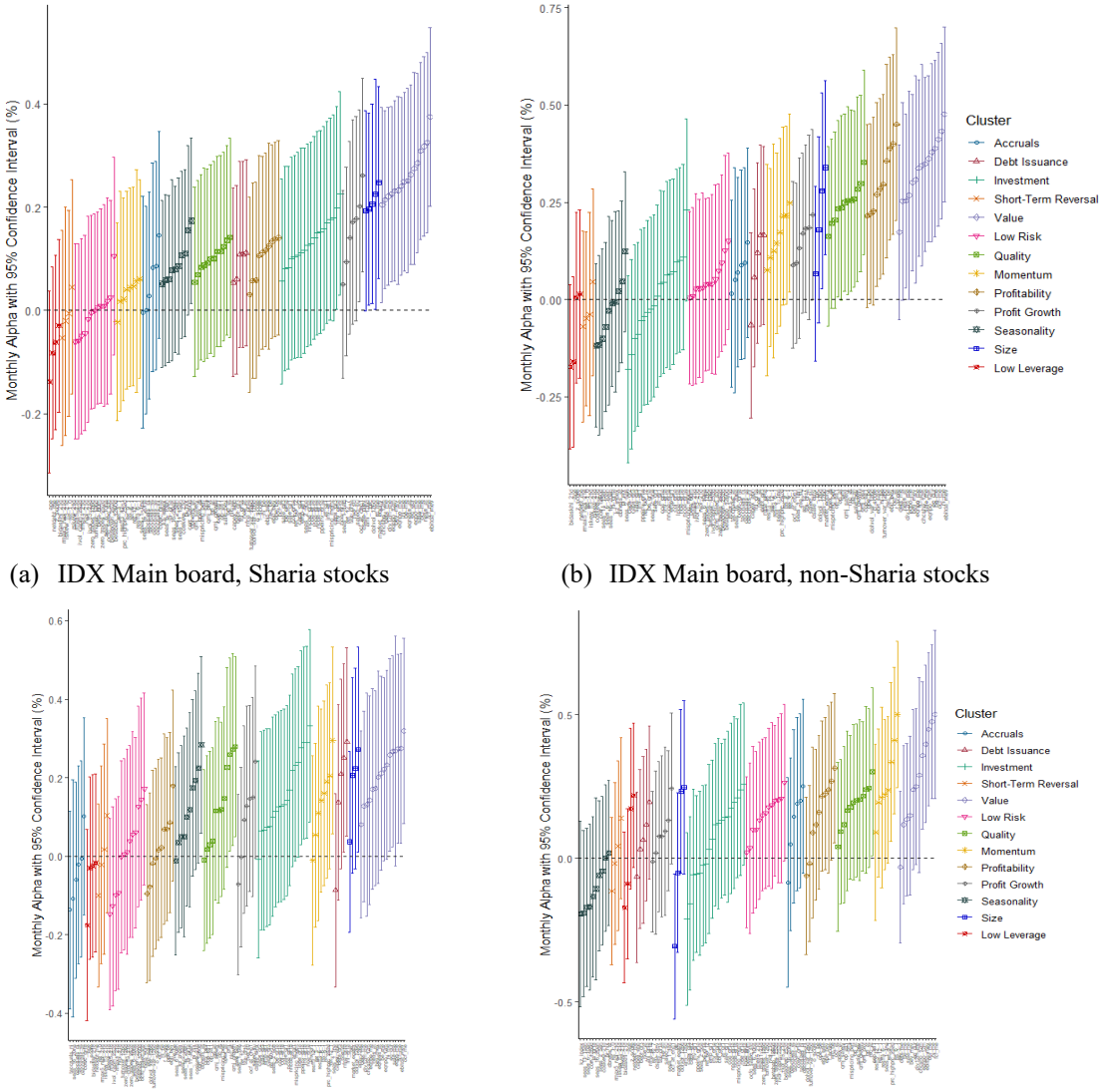


(c) NYSE non-micro, Sharia stocks



(d) NYSE non-micro, non-Sharia stocks

Figure 6: Replication rates by cluster for Sharia and non-Sharia stocks
Sharia and non-Sharia stocks adhering to and violating Islamic principles are sorted into quintile portfolios by IDX Main board breakpoints of 117 firm characteristic (panel a and b) and by NYSE non-micro breakpoints of 114 firm characteristics (panel c and d) with significant predictivity for future stock returns as in prior studies. The figure shows percentages of long-short portfolios with significant alphas under the EB for Sharia (panel a and c) and non-Sharia (panel b and d) stocks.



(a) IDX Main board, Sharia stocks

(b) IDX Main board, non-Sharia stocks

(c) NYSE non-micro, Sharia stocks

(d) NYSE non-micro, non-Sharia stocks

Figure 7: Average EB posterior alphas and confidence intervals of factors by cluster for Sharia and non-Sharia stocks

Sharia and non-Sharia stocks adhering to and violating Islamic principles are sorted into quintile portfolios by IDX Main board breakpoints of 117 firm characteristic (panel a and b) and by NYSE non-micro breakpoints of 114 firm characteristics (panel c and d) with significant predictivity for future stock returns as in prior studies. The figure shows EB posterior alphas and associated 95% confidence internals of each factor clustered into 13 themes for Sharia (panel a and c) and non-Sharia (panel b and d) stocks.

Appendix for

"Risk Factors in the Indonesia Stock Market"

Appendix A: List of variable names

Appendix B: Additional Tables and Figures

Table A1: Estimated EB Parameters

Table A2: Factors of the IDX with IDX all breakpoints

Figure A1: Replication rates by cluster with IDX all breakpoints

Figure A2: Average posterior alphas and confidence intervals of factors by cluster them with IDX all breakpoints

Appendix C: References for papers related to factors

Appendix A: List of variable names

Cluster	Characteristic	Reference Paper
Accruals	Change in current operating working capital	Richardson et al. (2005)
	Operating accruals	Sloan (1996)
	Percent operating accruals	Hafzalla, Lundholm, and Van Winkle (2011)
	Years 16-20 lagged returns, nonannual	Heston and Sadka (2008)
	Total accruals	Richardson et al. (2005)
	Percent total accruals	Hafzalla, Lundholm and van Winkle (2011)
Debt issuance	Abnormal corporate investment	Titman, Wei, and Xie (2004)
	Growth in book debt (3 years)	Lyandres, Sun, and Zhang (2008)
	Change in financial liabilities	Richardson et al. (2005)
	Change in noncurrent operating liabilities	Richardson et al. (2005)
	Change in net financial assets	Richardson et al. (2005)
	Earnings persistence	Francis et al. (2004)
	Net operating assets	Hirshleifer et al. (2004)
Investment	Liquidity of book assets	Ortiz-Molina and Phillips (2014)
	Asset Growth	Cooper Gulen and Schill (2008)
	Change in common equity	Richardson et al. (2005)
	CAPEX growth (1 year)	Xie (2001)
	CAPEX growth (2 years)	Anderson and Garcia-Feijoo (2006)
	CAPEX growth (3 years)	Anderson and Garcia-Feijoo (2006)
	Change in current operating assets	Richardson et al. (2005)
	Change in current operating liabilities	Richardson et al. (2005)
	Hiring rate	Belo, Lin, and Bazdresch (2014)
	Inventory growth	Belo and Lin (2011)
	Inventory change	Thomas and Zhang (2002)
	Change in long-term net operating assets	Fairfield, Whisenant, and Yohn (2003)
	Mispricing factor: Management	Stambaugh and Yuan (2016)
	Change in noncurrent operating assets	Richardson et al. (2005)
	Change in net noncurrent operating assets	Richardson et al. (2005)
	Change in net operating assets	Hirshleifer et al. (2004)
	Change PPE and Inventory	Lyandres, Sun and Zhang (2008)
	Long-term reversal	De Bondt and Thaler (1985)
	Sales Growth (1 year)	Lakonishok, Shleifer and Vishny (1994)
	Sales Growth (3 years)	Lakonishok, Shleifer and Vishny (1994)
	Sales growth (1 quarter)	Jensen, Kelly, and Pedersen (2022)
	Years 2-5 lagged returns, nonannual	Heston and Sadka (2008)
Low leverage	Firm age	Jiang, Lee, and Zhang (2005)
	Liquidity of market assets	Ortiz-Molina and Phillips (2014)
	Book leverage	Fama and French (1992)
	The high-low bid-ask spread	Corwin and Schultz (2012)
	Cash-to-assets	Palazzo (2012)
	Net debt-to-price	Penman, Richardson, and Tuna (2007)
	Earnings volatility	Francis et al. (2004)
	Asset tangibility	Hahn and Lee (2009)
	Altman Z-score	Dichev (1998)
Low risk	Market Beta	Fama and MacBeth (1973)
	Dimson beta	Dimson (1979)
	Frazzini-Pedersen market beta	Frazzini and Pedersen (2014)
	Downside beta	Ang, Chen, and Xing (2006)
	Earnings variability	Francis et al. (2004)
	Idiosyncratic volatility from the CAPM (21 days)	Jensen, Kelly, and Pedersen (2022)
	Idiosyncratic volatility from the CAPM (252 days)	Ali, Hwang, and Trombley (2003)
	Idiosyncratic volatility from the Fama-French 3-factor model	Ang et al. (2006)
	Idiosyncratic volatility from the q-factor model	Jensen, Kelly, and Pedersen (2022)
	Cash flow volatility	Huang (2009)
	Maximum daily return	Bali, Cakici, and Whitelaw (2011)
	Highest 5 days of return	Bali, Brown, Murray, and Tang (2017)
	Return volatility	Ang et al. (2006)

	Years 6-10 lagged returns, nonannual	Heston and Sadka (2008)
	Share turnover	Datar, Naik, and Radcliffe (1998)
	Number of zero trades with turnover as tiebreaker (6 months)	Liu (2006)
	Number of zero trades with turnover as tiebreaker (1 month)	Liu (2006)
	Number of zero trades with turnover as tiebreaker (12 months)	Liu (2006)
Momentum	Current price to high price over last year	George and Hwang (2004)
	Residual momentum t-12 to t-1	Blitz, Huij, and Martens (2011)
	Residual momentum t-6 to t-1	Blitz, Huij, and Martens (2011)
	Price momentum t-12 to t-1	Jegadeesh and Titman (1993)
	Price momentum t-3 to t-1	Jegedeesh and Titman (1993)
	Price momentum t-6 to t-1	Jegadeesh and Titman (1993)
	Price momentum t-9 to t-1	Jegedeesh and Titman (1993)
	Year 1-lagged return, nonannual	Heston and Sadka (2008)
Profit growth	Change sales minus change Inventory	Abarbanell and Bushee (1998)
	Change sales minus change receivables	Abarbanell and Bushee (1998)
	Change sales minus change SG&A	Abarbanell and Bushee (1998)
	Change in quarterly return on assets	Jensen, Kelly, and Pedersen (2022)
	Change in quarterly return on equity	Jensen, Kelly, and Pedersen (2022)
	Standardized earnings surprise	Foster, Olsen, and Shevlin (1984)
	Change in operating cash flow to assets	Bouchard, Krüger, Landier and Thesmar (2019)
	Price momentum t-12 to t-7	Novy-Marx (2012)
	Labor force efficiency	Abarbanell and Bushee (1998)
	Standardized Revenue surprise	Jegadeesh and Livnat (2006)
	Year 1-lagged return, annual	Heston and Sadka (2008)
	Tax expense surprise	Thomas and Zhang (2011)
Profitability	Coefficient of variation for dollar trading volume	Chordia, Subrahmanyam, and Anshuman (2001)
	Return on net operating assets	Soliman (2008)
	Profit margin	Soliman (2008)
	Pitroski F-score	Piotroski (2000)
	Return on equity	Haugen and Baker (1996)
	Quarterly return on equity	Hou, Xue, and Zhang (2015)
	Ohlson O-score	Dichev (1998)
	Operating cash flow to assets	Bouchard, Krüger, Landier, and Thesmar (2019)
	Operating profits-to-book equity	Fama and French (2015)
	Operating profits-to-lagged book equity	Jensen, Kelly, and Pedersen (2022)
	Coefficient of variation for share turnover	Chordia, Subrahmanyam, and Anshuman (2001)
Quality	Capital turnover	Haugen and Baker (1996)
	Cash-based operating profits-to-book assets	Jensen, Kelly, and Pedersen (2022)
	Cash-based operating profits-to-lagged book assets	Ball et al. (2016)
	Change gross margin minus change sales	Abarbanell and Bushee (1998)
	Gross profits-to-assets	Novy-Marx (2013)
	Gross profits-to-lagged assets	Jensen, Kelly, and Pedersen (2022)
	Mispricing factor: Performance	Stambaugh and Yuan (2016)
	Number of consecutive quarters with earnings increases	Barth, Elliott, and Finn (1999)
	Quarterly return on assets	Balakrishnan, Bartov, and Faurel (2010)
	Operating profits-to-book assets	Jensen, Kelly, and Pedersen (2022)
	Operating profits-to-lagged book assets	Ball et al. (2016)
	Operating leverage	Novy-Marx (2011)
	Quality minus Junk: Composite	Assness, Frazzini, and Pedersen (2018)
	Quality minus Junk: Growth	Assness, Frazzini, and Pedersen (2018)
	Quality minus Junk: Profitability	Assness, Frazzini, and Pedersen (2018)
	Quality minus Junk: Safety	Assness, Frazzini, and Pedersen (2018)
	Assets turnover	Soliman (2008)
Seasonality	Market correlation	Assness, Frazzini, Gormsen, and Pedersen (2020)
	Coskewness	Harvey and Siddique (2000)
	Net debt issuance	Bradshaw, Richardson, and Sloan (2006)
	Kaplan-Zingales index	Lamont, Polk, and Saa-Requejo (2001)
	Change in long-term investments	Richardson et al. (2005)

	Taxable income-to-book income	Lev and Nissim (2004)
	Years 11-15 lagged returns, annual	Heston and Sadka (2008)
	Years 11-15 lagged returns, nonannual	Heston and Sadka (2008)
	Years 16-20 lagged returns, annual	Heston and Sadka (2008)
	Years 2-5 lagged returns, annual	Heston and Sadka (2008)
	Years 6-10 lagged returns, annual	Heston and Sadka (2008)
	Change in short-term investments	Richardson et al. (2005)
Short-term reversal	Idiosyncratic skewness from the CAPM	Jensen, Kelly, and Pedersen (2022)
	Idiosyncratic skewness from the Fama-French 3-factor model	Bali, Engle, and Murray (2016)
	Idiosyncratic skewness from the q-factor model	Jensen, Kelly, and Pedersen (2022)
	Short-term reversal	Jegadeesh (1990)
	Highest 5 days of return scaled by volatility	Assness, Frazzini, Gormsen, and Pedersen (2020)
	Total skewness	Bali, Engle, and Murray (2016)
Size	Amihud Measure	Amihud (2002)
	Dollar trading volume	Brennan, Chordia, and Subrahmanyam (1998)
	Market Equity	Banz (1981)
	Price per share	Miller and Scholes (1982)
Value	Assets-to-market	Fama and French (1992)
	Book-to-market equity	Rosenberg, Reid, and Lanstein (1985)
	Book-to-market enterprise value	Penman, Richardson, and Tuna (2007)
	Net stock issues	Pontiff and Woodgate (2008)
	Debt-to-market	Bhandari (1988)
	Dividend yield	Litzenberger and Ramaswamy (1979)
	Ebitda-to-market enterprise value	Loughran and Wellman (2011)
	Equity duration	Dechow, Sloan, and Soliman (2004)
	Net equity issuance	Bradshaw, Richardson, and Sloan (2006)
	Equity net payout	Daniel and Titman (2006)
	Net payout yield	Boudoukh et al. (2007)
	Payout yield	Boudoukh et al. (2007)
	Free cash flow-to-price	Lakonishok, Shleifer, and Vishny (1994)
	Intrinsic value-to-market	Frankel and Lee (1998)
	Net total issuance	Bradshaw, Richardson, and Sloan (2006)
	Earnings-to-price	Basu (1983)
	Operating cash flow-to-market	Desai, Rajgopal, and Venkatachalam (2004)
	Sales-to-market	Barbee, Mukherji, and Raines (1996)

Appendix B: Additional Tables and Figures

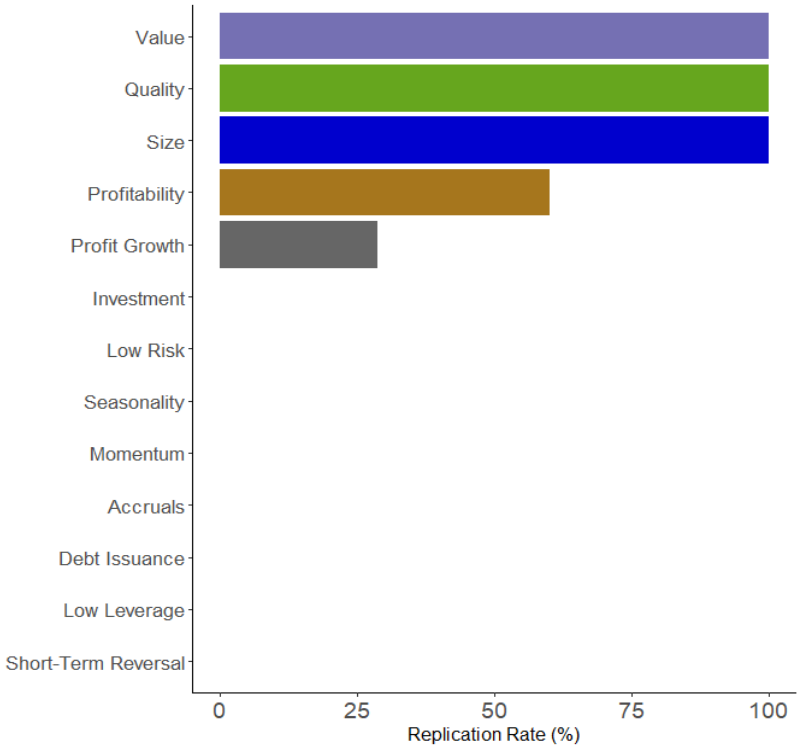
Table A1: Estimated EB parameters
This table tabulates the estimated empirical Bayesian hyperparameters under different portfolio sorting breakpoints among different samples of IDX stocks. τ_c is the standard deviation of cluster-specific alpha, and τ_w is standard deviation of idiosyncratic factor alpha.

Sorting Method and Sample	τ_c	τ_w
All stock, IDX Main board breakpoints	0.190	0.089
Sharia stock, IDX Main board breakpoints	0.141	0.083
Non-Sharia stock, IDX Main board breakpoints	0.182	0.124
All stock, IDX total breakpoints	0.194	0.095
Sharia stock, IDX total breakpoints	0.159	0.084
Non-Sharia stock, IDX total breakpoints	0.190	0.111
All stock, NYSE non-micro breakpoints	0.202	0.120
Sharia stock, NYSE non-micro breakpoints	0.133	0.140
Non-Sharia stock, NYSE non-micro breakpoints	0.152	0.123

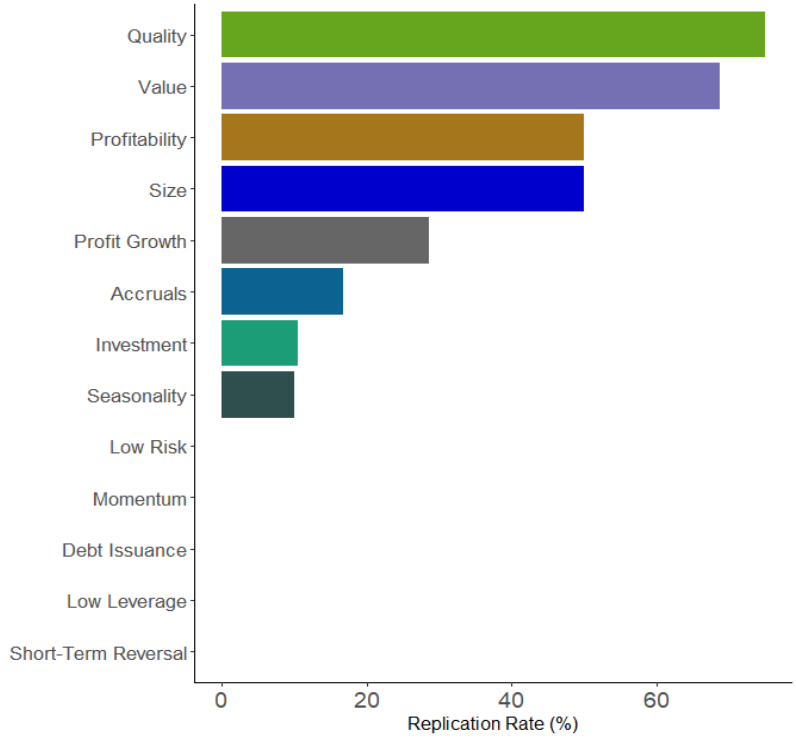
Table A2: Factors of the IDX with total IDX breakpoints

Stocks are sorted into quintiles by firm characteristics with significant predictive power for future stock returns documented in the original markets where factors are first proposed. We use breakpoints of all stocks listed on the IDX to sort portfolios. Factors are clustered into 13 themes. #var is the number of variables in each cluster. #sig is the number of significant factors in the Indonesia market under the empirical Bayesian (EB) and OLS framework. $\overline{\alpha}^{EB}$ and $\overline{\alpha}^{OLS}$ are average values of posterior alpha and OLS alpha of significant factors under the EB and OLS methods, respectively. Factor RR is replication rate, defined as the number of factors significant in the IDX out of the number of factors significant in the original studies. Mean value of alphas and replication rates are reported in percentage. The sample period is from January 2001 throughout December 2022.

			EB			OLS	
Cluster	#Var	#Sig	RR%	$\bar{\alpha}^{EB}$	#Sig	RR	$\bar{\alpha}^{OLS}$
Accruals	6	.	.	.	1		0.35
Debt Issuance	5	.	.	.	.	.	.
Investment	19	.	.	.	2		0.34
Low Leverage	4	.	.	.	.	.	.
Low Risk	13	.	.	.	.	.	.
Momentum	8	.	.	.	.	.	.
Profit Growth	7	2	28.57%	0.27	2	28.57%	0.54
Profitability	10	6	60.00%	0.25	5	50.00%	0.42
Quality	12	12	100.00%	0.26	9	75.00%	0.45
Seasonality	10	.	.	.	1	10.00%	0.38
Short-Term Reversal	4	.	.	.	.	.	.
Size	4	4	100.00%	0.31	2	50.00%	0.44
Value	16	16	100.00%	0.37	11	68.75%	0.51
Total	118	40	33.90%		33	27.97%	



(a) EB



(b) OLS

Figure A1: Replication rates by cluster with total IDX breakpoints
IDX stocks sorted into quintile portfolios by total IDX breakpoints of 118 firm characteristic with significant predictivity for future stock returns as in prior studies. The figure shows percentages of long-short portfolios with significant alphas under the EB (panel a) and the OLS (panel b) methods out of the number of factors in each cluster theme.

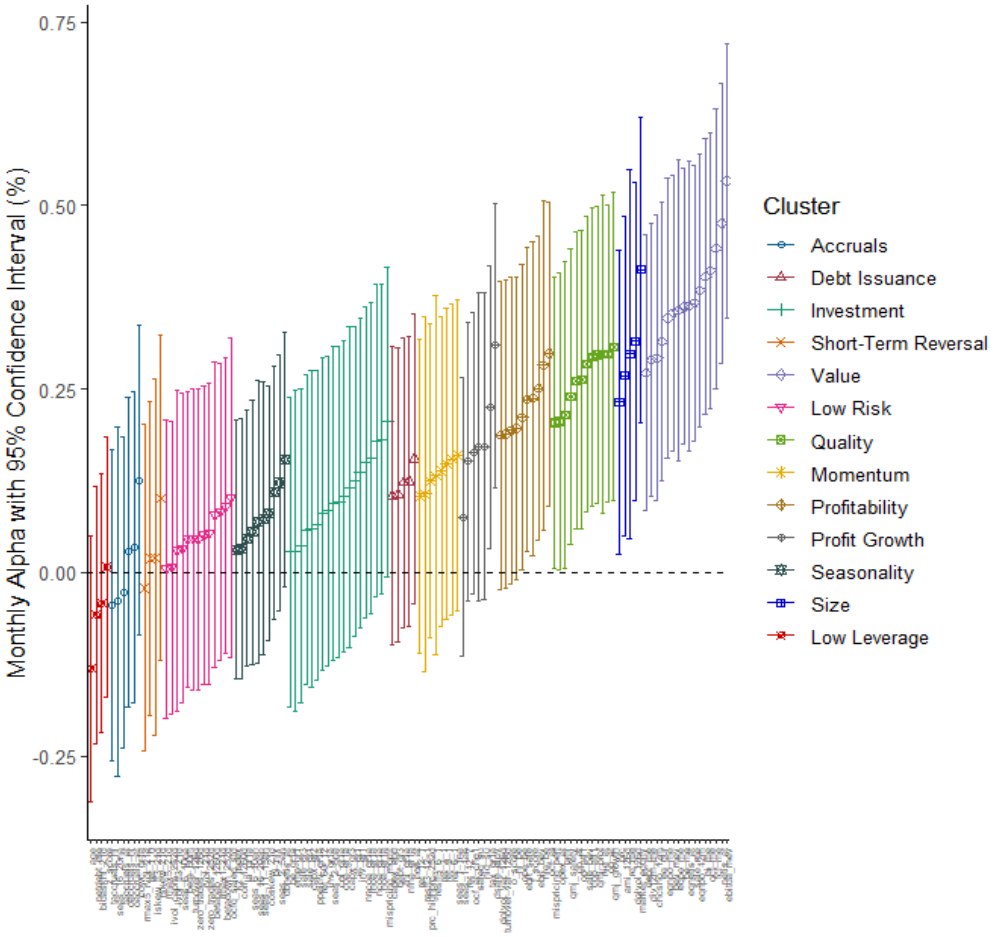


Figure A2: Average EB posterior alphas and confidence intervals of factors by cluster them with total IDX breakpoints
IDX stocks sorted into quintile portfolios by total IDX breakpoints of 118 firm characteristic with significant predictivity for future stock returns as in prior studies. The figure shows EB posterior alphas and associated 95% confidence internals of each factor clustered into 13 themes

Appendix C: References for papers related to factors

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