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Article

Human capital in asset pricing: The case of the Brazilian stock market during crisis periods

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Abstract. In recent years, multi-factor models outperformed traditional models in explaining the cross-sectional variability in asset returns. Therefore, the current study examines the performance of the human capital-based six-factor model in the Brazilian stock market for the period spanning from July 2010 to June 2023. This study takes daily stock price data of non-financial firms and constructs a set of thirty-two portfolios sorted on size, value, profitability, investment, and labor income growth. Moreover, this study includes human capital as an additional factor in the Fama and French five-factor model, thus proposing an augmented six-factor model. We use Fama and Macbeth's (1973) two-step estimation approach for the empirical analysis. Findings indicate that small stock portfolios earn higher returns than big ones. Further, findings reveal that market size, value, profitability, investments, and labor income growth (proxy of human capital) premium significantly explain the time series variability in excess portfolio returns. Furthermore, we find that the Brazilian economic crisis and the COVID-19 pandemic create identical volatility in the stock markets, which reduces the performance of the six-factor model during an economic crisis and pandemic period. Additionally, we employ the Gibbons, Ross, and Shanken (GRS) test to evaluate the model's performance in sub-sample analysis. Lastly, the findings report important implications for policymakers, investors, and portfolio managers to select appropriate portfolios for investment during economic turmoil.

Keywords: Fama-MacBeth regression, human capital, asset pricing models, COVID-19

JEL classifications : C22, C53, E24, J24, G11, G12

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1. Introduction

Over the past few decades, asset pricing models have been the subject of much research to test the performance of these models for explaining the cross-sectional variability in asset returns (Khan & Afeef, 2024; Khan et al., 2023; Mohanasundaram & Kasilingam, 2024). Referring to the risk and return framework, investors and portfolio managers desire a fair valuation of stocks. In this context, Markowitz (1952) highlights that investors often have specific preferences over portfolio selection. Following this, Sharpe (1964), Lintner (1965), and Mossin (1966) proposed a capital asset pricing model (CAPM, hereafter) which determines a relationship between the price of individual assets (stocks) and their associated risk. Similarly, Merton (1969) used the CAPM framework to jointly determine consumption and select portfolios. Following this, many researchers criticized the limitations of CAPM (Bhandari, 1988; Friend et al., 1978; Roll, 1977) and introduced many anomalies that explain cross-sectional variability in asset returns (Banz, 1981; Rosenberg et al., 1985; Linnainmaa & Roberts, 2018).

Similarly, Cox et al. (1985) extend the CAPM with savings and capital formation for portfolio selections. As the CAPM is based on a single factor, researchers have progressively introduced many anomalies to claim the success of the multi-factor model (Harvey et al., 2016). Following this, Hou et al. (2020) identified 452 financial anomalies and concluded that around 35% were found statistically significant for explaining the variability in asset returns.

For instance, Fama and French (1993) extend the CAPM with two prominent factors: size and value premium, thus proposing a three-factor model (FF3FM, hereafter). Later, Carhart (1997) extended FF3FM with a momentum factor, thus proposing the Carhart four-factor model (C4FM, hereafter). Moreover, Fama and French (2015) proposed a five-factor model (FF5FM, hereafter), which includes two factors (investment and profitability) in FF3FM. Similarly, Fama and French (2018) extend their five-factor model with momentum, thus proposing a six-factor model (FF6FM, hereafter). In addition, they also proposed a non-nested six-factor model (FF6CP, hereafter) substituting cash profitability with operating profitability.

Over time, a growing body of literature has expanded upon the initial research, exploring the impact of human capital, which constitutes a significant portion of total wealth. Empirical evidence suggests that human capital-related risk is a crucial aggregate factor that market beta fails to capture fully (Qin, 2002). More specifically, Campbell (1996) demonstrates that aggregate market risk is the main factor that determines excess returns. Further, the author remarked that in the presence of human capital, the risk aversion coefficient is much higher than that of market risk. Similarly, empirical tests by Jagannathan and Wang (1996) show that incorporating human capital betas into the conditional CAPM significantly enhances its ability to explain the cross-sectional behavior of U.S. stock returns. Extending this analysis to Japanese markets, Jagannathan et al. (1998) find that the CAPM performance improves when human capital betas are considered.

The study of human capital, institutional conditions, and structural change as key drivers of sustainable economic growth is particularly relevant for Emerging Economies (EEs). As these countries exhibit distinct characteristics such as high levels of poverty and inequality (Amar et al., 2020), an inefficient manufacturing base (Wang et al., 2020), and persistent corruption and political instability (Vianna & Mollick, 2018) which have historically hindered effective governance and economic control throughout their development. More precisely, the stock and quality of human capital are strongly linked to innovation and structural transformation within society (Romer, 1990; Diebolt & Hippe, 2019). Human capital can be measured through various dimensions, including education, intelligence, research activities, and health (Garza-Rodriguez & Almeida-Velasco, 2020). Human capital accumulation is a key driver of sustainable economic growth, particularly for EEs (Tridico, 2007).

Building on the theoretical foundation, human capital accounts for approximately 90% of aggregate wealth (Lustig et al., 2013); this underscores the necessity of integrating human capital into asset pricing frameworks. More specifically, a large number of studies confirm a strong correlation between human capital and expected stock returns (Berk & Walden, 2013; Betermier et al., 2012; Lustig & Van Nieuwerburgh, 2008; Santos & Veronesi, 2006). As Campbell (1996) suggests, integrating pricing factors into the intertemporal capital asset pricing model (ICAPM), which includes human capital and macroeconomic variables, could enhance model performance. Therefore, considering the effect of human capital on stock returns, Roy and Shijin (2018) extend the FF5FM with human capital as an additional factor, thus proposing the human capital six-factor model (HC6FM, hereafter). Their study provided empirical evidence that market factors and human capital components collectively explain variations in asset return predictability for the vast majority of assets. Furthermore, they remarked that the human capital component subsumes the explanatory power of size and value strategies in return for predictability. Recently, several studies tested the supremacy of HC6FM over FF5FM for explaining the cross-sectional variability in excess portfolio returns (Maiti & Balakrishan, 2018; Florensia

& Susanti, 2020; Maiti & Vukovic, 2020; Tambosi et al., 2022; Khan et al., 2022; Khan et al., 2023; Thalassinos et al., 2023).

In 2009, Brazil ranked the world's eighth-largest economy, and from 1995 to 2006, Brazilian exports grew at an average annual rate of 9.75%. Similarly, during this period, exports from Pernambuco increased by just 0.39% on average per year, whereas Mato Grosso experienced a significantly higher growth rate of 17.15% annually. These differences highlight regional disparities in economic resources, labor distribution, and educational attainment across Brazilian states (Fraga & Bacha, 2012). Similarly, in Brazil, human capital plays a vital role in influencing foreign direct investment (FDI), financial market development, and investor confidence. For instance, a highly skilled labor force enhances productivity and innovation, making the country more attractive to multinational corporations and institutional investors (Borensztein et al., 1998; Lucas, 1988). Moreover, improved human capital is associated with improved governance and less information asymmetry (Acemoglu & Johnson, 2005). Further, in Brazil, a strong link exists between international capital flows and asset price movements. Foreign portfolio inflows increase, market liquidity, lower risk premiums, and contribute to asset price stability (Bekaert & Harvey, 2000).

In the recent past, the stock markets have seen unprecedented crises, for instance, the Asian financial crisis of 1997, the global financial crisis (GFC) of 2007-2009, the European debt crisis in 2010, natural calamities, pandemics, and country-specific crises have disrupted the financial systems. Similarly, the Brazilian economy reported a negative GDP growth in response to the GFC. However, in the next decade, the Brazilian economy lost momentum, and in the middle of 2014, the Brazilian economy faced one of the worst recessions in history. Further, according to Holland (2019), the economic crisis in Brazil lasted for 11 quarters, severely affecting the economy. Moreover, according to the Economic Commission for Latin America and the Caribbean (2020)[1]. After the economic crisis, the Brazilian economy reported a steady economic recovery, but in 2020, the COVID-19 pandemic adversely affected the economy. Further, financial crises, recessions, and pandemics seriously affect employment, economic growth, and development, ultimately increasing financial market risks (Horta et al., 2014; Maciel, 2024). More specifically, a growing number of studies concluded that emerging markets, including Brazil, exhibit higher volatility, lower market stability, macroeconomic instability, weak governance and investor protections, and political unrest (Bekaert et al., 1997; La Porta et al., 1998; Aggarwal et al., 2018). Therefore, we select the Brazilian economy for several reasons. First, the dynamics of the Brazilian market provide valuable insights for asset pricing research. As an emerging economy and a key BRICS member, Brazil exhibits a financial landscape distinct from developed markets. While emerging markets offer high growth potential, they pose challenges such as increased volatility, political and economic instability, and weaker investor protections. These factors influence market efficiency, risk premiums, and investor behavior, which affect asset pricing models' applicability (Khan et al., 2022). Second, the Brazilian economic crisis and the COVID-19 pandemic severely affected the stock market. Third, studying the role of human capital in asset pricing is appropriate, which gives exposure to foreign capital flows and integration into global financial markets (Rezende et al., 2019; Kostin et al., 2022).

Therefore, investing during crises poses significant challenges for investors and portfolio managers in adhering to efficient asset pricing models for diversification. This raises a critical question: Do asset pricing models predict the time series variability in portfolio returns during crises and pandemic periods? To answer this question, we examine the performance of the augmented human capital six-factor model during an economic crisis and the COVID-19 pandemic in the Brazilian stock market. For the empirical analysis, we employ Fama and Macbeth's (1973) two-pass estimation approach, and findings indicate that the economic crisis and COVID-19 pandemic create identical

[1] https://repositorio.cepal.org/server/api/core/bitstreams/e846340c-7f8a-4f05-8b66-8f63915aecfa/content

volatility in the Brazilian stock market; in response to that, most of the portfolios show inefficient returns with higher risk.

Further, we report that small portfolios report considerably higher returns along with a higher value of risk in comparison to large portfolios. Additionally, we find that the market premium significantly explains the time series variability in all sets of portfolios. We find a significant relationship between these factors and excess portfolio returns for size, value, profitability, and investment premium. Furthermore, the labor income growth rate (proxy of human capital) significantly explains the time-series variability in excess portfolio returns. Moreover, the six-factor model performs better in the entire sample than in the crisis and pandemic periods. Concurrently, we report that the performance of the six-factor model significantly increased during the crisis and the COVID-19 pandemic compared to pre-crisis periods. These findings indicate that the augmented human capital-based six-factor model significantly explains the time series variability in crisis periods. Further, findings report important implications for policymakers, investors, and portfolio managers to diversify their investments in uncertain times.

The paper's reminder is organized as follows: The next section provides a plethora of theoretical and empirical evidence on the nexus between risk factors and returns. Section 3 discusses the data, portfolio construction, and research methodology. Section 4 discusses the study's empirical findings, and Section 5 concludes the paper with policy implications.

2. Literature Review

2.1 Theoretical Nexus of Asset Pricing

The Modern Portfolio Theory (MPT) proposed by Markowitz (1952) laid the foundation for asset pricing studies. Concurrently, Tobin (1958b) introduced the 'key separation theorem,' which posits that any risk-averse investor chooses between a risk-free asset and a portfolio of risky assets. Building on this, Sharpe (1964), Lintner (1965), and Mossin (1966) applied the Tobin-Markowitz mean-variance framework to develop the CAPM and an extended version of the CAPM (Mossin, 1968; Samuelson, 1969). Later, Fama (1970) proposed the Efficient Market Hypothesis (EMH) based on the CAPM, which posits that if expected stock returns are determined using the Sharpe-Lintner-Mossin two-parameter model, then security prices fully incorporate all available information.

Similarly, Ross (1976) proposed the multi-factor model, also known as arbitrage pricing theory (thereafter, APT), which proposed several factors that capture broad market risks. Several studies identify numerous anomalies that explain the cross-sectional variability in asset returns. For instance, the price-to-earnings anomaly of Basu (1977), the size anomaly of Benz's (1981) earnings to the price of Basu's (1983) debt, the equity anomaly of Bahandari (1988), and the book-to-market value equity anomaly of Rosenberg et al. (1985). Similarly, Connor (1984) proposed a new equilibrium version of APT. The authors find that APT and the new proposed version of APT, which includes equilibrium, are similar in predicting the variability in stock prices and portfolio returns. Similarly, Fama and French (1992) explore the combined effect of market beta, size, leverage, earnings-to-price ratio, and book-to-market ratio on stock returns. It finds that market beta (β), size, and book-to-market ratio significantly explain the variation (cross-sectional) in expected stock returns. Jegadeesh and Titman (1993) explore the phenomenon of stock market performance. It finds that stocks that performed well in the past (buy option) and those that performed poorly significantly earned positive returns. A growing body of literature reports the persistence of mutual funds' performance in common investment strategies over short and long-term horizons (Hendricks et al., 1993; Goetzmann & Ibbotson, 1994; Brown et al., 1995; Wermers, 1996; Grinblatt & Titman, 1992; Elton et al., 1993; Elton et al., 1996a).

2.2 Empirical Nexus of Asset Pricing

Garcia and Bonomo (2001) evaluate the performance of numerous conditional asset pricing models in the Brazilian stock market. The author finds that portfolio betas effectively capture the evolution of risk during the estimation period, and the predicted mean returns align closely with actual returns. Hou et al. (2015) construct a new empirical model based on the neoclassical q investment theory, which summarizes the cross-section of average stock returns. Their findings indicate that when tested against 35 prominent anomalies in the broad cross-section, the q-factor model outperforms the traditional model. Kayo et al. (2020) propose alternative procedures to estimate the cost of equity through CAPM in Brazil's electricity transmission context. Additionally, the authors test beta stability by three elements of CAPM, and their findings indicate that achieving desirable beta stability is possible using a Brazilian pure-play global beta, estimated over an 11-year window.

Similarly, González-Sánchez (2022) evaluates the performance of the factorial versus information stochastic discount factor (SDF) model, using data from 28 emerging countries. The author finds that portfolios in the SDF model report better goodness of fit than the factorial model. Carrasco and Hansen (2022) investigate the role of uncertainty in asset pricing models. Using the Bayesian mean-variance, their findings indicate that uncertainty in the model significantly improves the portfolio performance. Son and Lee (2022) proposed the latent asset pricing model to estimate the risk exposure based on the characteristics of firms. Using Graph Convolutional Newton (GCN), their findings indicate that the GCN model outperforms other asset pricing models. Concurrently, Kolari et al. (2022) compare the performance of ZCAPM with traditional asset pricing models, namely, CAPM, FF3FM, and C4FM. Using the global sample, the authors find that out of the sample, the ZCAPM outperforms FF3FM and C4FM in terms of returns dispersion.

More precisely, Alessi et al. (2023) examine the role of greenium (carbon emission and environmental transparency) in asset returns. The authors find that European investors hold greenium stock with low equity returns. Nettayanun (2023) examined the performance of the augmented-q factor model and FF6FM during full, bear, and bullish market conditions. The author finds that the q-factor model performs well overall and in bull markets, whereas FF6FM performs well in bear markets.

Further, Zhou (2024) examined the performance of six-factor models in the Chinese stock market, using a profit-income trading behavior proxy; their findings indicate that the Chinese stock market is structurally efficient. Moreover, they reported that large-size and high-volume portfolios performed well regarding liquidity and trading premiums. Kausar et al. (2024) examined the determinants of idiosyncratic risk (IR) in BRICS economies. Using the panel data models, the authors document that higher IR firms report lower returns than lower IR firms. Mohanasundaram and Kasilingam (2024) investigate the performance of sustainability factors in asset pricing models, using the Fama and MacBeth two-pass regression and the Fama and French methodology. The authors conclude that the sustainability factor (ESG) positively and significantly impacts portfolio returns. Silva et al. (2025) explore the role of the investor sentiment index in asset pricing models, namely FF3FM and C4FM. Their findings, using mutual funds, indicate that the investor sentiment-based asset pricing model fails to accurately predict the cross-sectional variability in asset returns in the Brazilian market.

2.3 Role of Human Capital in the Asset Pricing Model

The intertemporal consumption-based asset pricing model proposed by Lucas (1978) and Breeden (1979) is a widely used framework for integrating asset valuation into consumption-investment decisions. The foundation of this framework dates to a consumption-based theory of interest rates proposed by Fisher (1907), which contends that the yearly interest rate in equilibrium represents the marginal value of income today with the marginal value of income in the following year. Further, Mayers (1972) reported that a sizable amount of an individual's wealth may be held in non-marketable assets (human capital, HC), which are difficult to trade on financial markets. As a result, these non-marketable assets influence people's investment methods and portfolio choices. Moreover, Campbell (1996) argued that HC represents the actual wealth of the economy, and this factor plays a vital role in asset pricing. Further, a growing number of studies confirm that human capital based assets pricing models successfully predict the time series variability in assets returns (Jagannathan & Wang, 1996; Kim et al., 2011; Belo et al., 2017; Kuehn et al., 2017; Lettau et al., 2019). Many factors have been identified as necessary to construct an efficient portfolio in recent years. However, the available literature on asset pricing has overlooked the role of human capital (HC) in the asset pricing model (Prasad et al., 2024).

Following the aforementioned literature, we conclude that testing the performance of human capital-based six-factor models during economic crisis and COVID-19 in Brazilian stock markets remains scarce. To the best of our knowledge, a significant gap exists in the literature to examine the performance of these models. Therefore, our study contributes to the existing literature in the following ways: First, this study integrates the human capital factor as an additional factor into the FF5FM to test an augmented six-factor model in the Brazilian stock market. Second, we employ daily data to construct thirty-two portfolios, enhancing the robustness of our analysis. Third, we test the performance of the augmented human capital-based six-factor model across the different periods, including the entire sample, pre-crisis, during-crisis, post-crisis, and the COVID-19 pandemic. Fourth, we use Fama and MacBeth's (1973) two-pass estimation approach, which is widely used in asset pricing studies to get more enriched results.

3. Data and Methodology

To examine the performance of the human capital-based six-factor model during an economic crisis and the COVID-19 pandemic, we collect data from non-financial companies in multiple steps. First, we take daily data on stock prices for the period spanning from July 2010 to June 2023. Second, we take yearly balance sheet data from 2010 to 2022 for portfolio construction. Third, we take daily data of the Bovespa index and treasury bill rates from Thomson Reuters DataStream. Moreover, we removed the companies whose market capitalization (MC), profitability investment, and HC (growth in salaries and wages) for the sample period were inadequate or missing. Furthermore, we adopt Yamane's (1967) approach to determine the optimal sample size to enhance the generalizability of our results. Additionally, we follow the methodology of Zada et al. (2018) and Fama and French (1993), who employed a non-random sampling technique to select the optimal sample size based on market capitalization and firms continuously listed on the stock exchange. More specifically, the use of daily data in asset pricing studies, particularly in emerging markets like Brazil, is justified for several reasons. First, daily observations allow for a more detailed analysis of market dynamics, capturing short-term price fluctuations, volatility clustering, and immediate market reactions to economic events, which monthly data may overlook. Additionally, daily data improves the estimation of risk factors, which often change over short periods, thereby enhancing the precision of risk-return relationships. Moreover, emerging markets like Brazil tend to exhibit higher volatility and structural shifts, so studying return predictability over shorter intervals is crucial. Additionally, as the list of companies has changed due to further incorporations, mergers, and amalgamations, companies with irregular closing prices were removed from the sample. Furthermore, we remove the companies with a negative book equity value from our sample.

Moreover, survivorship bias, which is primarily linked to emerging markets, where data inconsistencies are more apparent, is not taken into account because we exclude the dead stocks from our sample (Bekaert & Harvey, 2000). Moreover, Elton et al. (1996b) document that survivorship bias may be reduced by decreasing the sample size to an optimum size. To this end, we are left with 234 non-financial companies for portfolio construction. Moreover, to provide a clearer picture of the sample used in this study, we comprehensively analyze the fraction of non-financial stocks included in the sample and their market capitalization relative to the entire Brazilian stock exchange (B3). As of recent data, this exchange has approximately 475 listed companies, and the total market capitalization of these listed companies is approximately BRL 4.80 trillion as of December 2023. To assess the representativeness of the study sample, we sum the market capitalization of all non-financial firms in our dataset and conclude that these non-financial firms represent around 85% of the market capitalization of all sectors (excluding financial) of the exchange.

Table 1: Variable Explanations and Computation

Variable	Proxy	Computation	References
Market Premium	MKT	RM-RF	Sharpe (1964)
Size Premium	SMB	Market Capitalization	Fama and French (1993)
Value Premium	HTML	Book value of equity/Market value of Equity	Fama and French (1993)
Profitability Premium	RMW	EBIT/Book value of Equity	Fama and French (2015)
Investment Premium	CMA	Growth in Total assets	Fama and French (2015)
Human Capital	LBR	Growth in Salaries and Wages	Roy and Shijin (2018), Khan et al. (2022), Thalassinos et al., 2023; Prasad et al. (2024)

Note: This table shows variable definition and computation.

3.1 Portfolio Construction

For portfolio construction, we followed the methodology of Fama and French (2015). First, we equally sorted the companies on market capitalization, and then the size-sorted companies were divided into low- and high-book-to-market ratio companies. Later, the value premium companies were further divided into robust and weak profitability companies. Following this, we sorted the profitable companies into aggressive and conservative investment companies. Finally, the equal-weighted sample was sorted based on low and high-labor-income growth stocks. Figure 1 illustrates the portfolio construction.

Figure 1. Portfolio construction

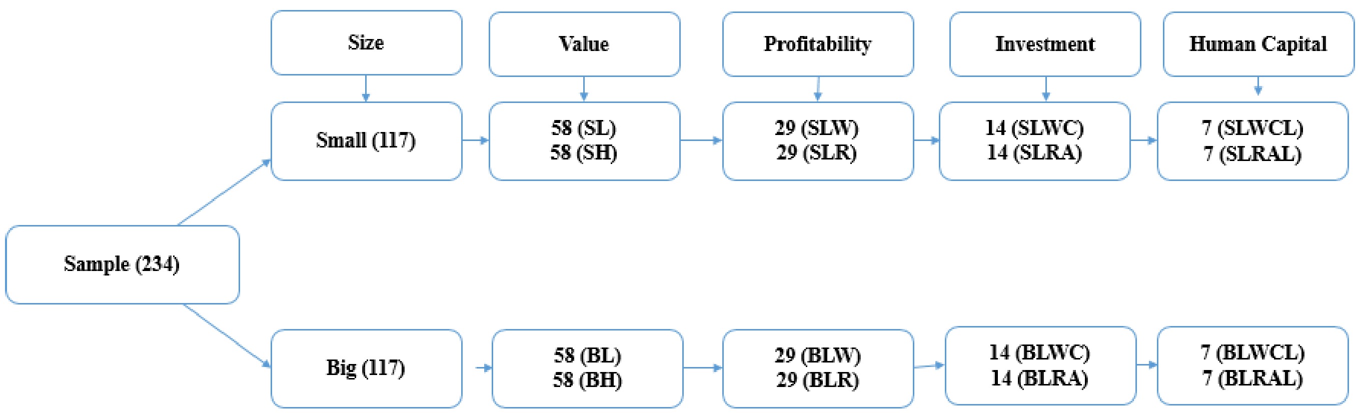

Fig 1: Portfolio Construction

Source: Author's own computation

3.2 Fama-MacBeth (1973) regressions

Recently, the significance of Fama and Macbeth (1973), a time series regression, has attracted the attention of many researchers worldwide to investigate the relationship between expected returns and risk factors. Consequently, this method is widely used in asset pricing studies (Zada et al., 2018; Khan et al., 2022; Khan et al., 2023). Therefore, in this study, we used the Fama and Macbeth (1973) regression approach by adding the human capital factor to the five-factor model of Fama and French (2015). Fama and Macbeth (1973) proposed a two-step regression approach to estimate the exposure of risk premiums in several stock markets. This approach is theoretically based on the Sharpe-Lintner model (CAPM), which states that Betas (β) significantly explain the cross-sectional variability in stock returns (Jagannathan et al., 2010). Moreover, this approach is commonly used in asset pricing studies, which involves regressing portfolio returns on risk factors in the first stage to estimate factor loadings (betas). Further, in the second stage, asset or portfolio returns are regressed cross-sectionally on the estimated betas. However, as noted by Jensen et al. (1972) and Fama and MacBeth (1973), the second-pass regression inherently suffers from an errors-in-variables (EIV) issue because the explanatory variables (betas) were obtained using first-pass regression. Furthermore, this issue is mitigated using diversified portfolio returns instead of individual stock returns. Additionally, Fama and MacBeth (1973) suggest running month-by-month regressions instead of averaging returns over the entire sample period to address cross-correlation in regression residuals. This approach allows betas to evolve (rolling betas), which are then used to predict stock returns in the subsequent period. More precisely, the first-pass regression provides estimates of betas, which serve as inputs for the second-pass regression.

Further, the standardized Fama and Macbeth regression is summarized as follows:

$$R_{it} = \alpha_i + \beta_{i1} f_{1t} + \cdots + \beta_{ik} f_{Kt} + \epsilon_{it}, \quad i = 1, .., N, \ \ t = 1, \dots, T, \tag{1}$$

In Equation (1), R_{it} is the return on asset for the period i in period t, f_{it} is the realization of the jth factor in period t, where ϵ_{it} shows the distribution of error terms. At the same time, N and T are the number of assets and time series observations.

Further, the underlying hypothesis for asset pricing is standardized as follows using the two-pass procedure:

$$H_0 = E[R_t] = \gamma_0 1_N + \gamma_1 \beta_1 + \cdots + \gamma_K \beta_K, \tag{2}$$

In Equation (2), $E[R_t]$ notates the N-vector of expected returns on the assets, while $y_1, \dots, y_k$ show the risk premia. Fama and Macbeth's (1973) rolling regression involves two steps: The first step is to regress the return of every asset against one or more risk factors using a time-series approach to obtain the return exposure of each factor, called the β. Let $\beta = (\beta, \dots, \beta_K)$ be the resulting $N \times K$ matrix of the ordinary least squares (OLS) estimates. The second step is regressing all asset returns against the asset betas obtained in Equation (1) using a rolling window approach as indicated in Equation (2).

3.3 Model Specification

The study uses the following econometric model to analyze the performance of the Brazilian stock market's human capital-based assets pricing model.

$$R_{it} - R_{ft} = \alpha_0 + \beta_1 MKT_t + \beta_2 SMB_t + \beta_3 HML_t + \beta_4 RMW_t + \beta_5 CMA_t + \beta_6 LBR_t + \epsilon_{it} \tag{3}$$

3.3.1. Fama and Macbeth (1973) Rolling Window Two-pass regression model

$$R_{it} - R_{ft} = \alpha_0 + \beta_1(\beta - MKT_t) + \beta_2(\beta - SMB_t) + \beta_3(\beta - HML_t) + \beta_4(\beta - RMW_t) + \beta_5(\beta - CMA_t) + \beta_6(\beta - LBR_t) + \varepsilon_{it} \tag{4}$$

In Equations (3) and (4), the term $R_{it} - R_{ft}$ represents the excess portfolio return, where R_{it} stands for the expected return of the portfolio and R_{ft} stands for the risk-free rate. The term $MKT_t = R_{Mt} - R_{ft}$ represents the risk premium factor, SMB_t is the size premium, HML_t is the value premium, and RMW_t is the profitability premium. CMA_t is the investment premium, LBR_t is the human capital premium, and ϵ_{it} is the model error term for firm i at time t.

3.4. Gibbons, Ross, and Shanken (GRS) test

Many asset pricing studies have recently widely used the GRS-Wald test statistics for portfolio performance. Gibbons et al. (1989) proposed this test to measure the mean-variance performance of a portfolio. The authors also proposed this test to measure the performance of CAPM and further investigate the sensitivity of stocks, the number of assets, and the choice of portfolio to derive the efficient frontier (Merton, 1972; Azam & Arif, 2024).

The following equation shows the estimation of the GRS test:

$$GRS = \left(\frac{T}{N}\right)\left(\frac{T}{T} \frac{-N-L}{-L-1}\right)\left[\frac{\hat{a}' \hat{\Sigma}_{-1} \hat{a}}{1+\bar{\mu}\, \widehat{\varphi^{-1}} \bar{\mu}}\right] \sim F(N, T-N-L) \quad (5)$$

where in Equation (5) the term, $\alpha = N\times1$, computes the error term vector (constant). Σ shows the stochastic term of the unbiased covariance matrix. μ=L×1 shows the average portfolio matrix, and φ shows the portfolio/factor unbiased covariance matrix. Similarly, T shows the number of observations, where N shows the number of regression equations, while L shows the number of factors included in the model. Furthermore, following equation (5), we also used the GRS-F test to test the hypothesis;

H_0: $\alpha_i = 0$, where i =1, 2, 3,…, N shows the number of periods, where all alpha coefficients equal zero.

H_1: $\alpha_i \neq 0$, where the i =1, 2, 3,…, N shows the number of periods, where all alpha coefficients are not equal to zero.

4. Results and Discussion

Table 2 shows the summary statistics of the thirty-two portfolios sorted on size, value, profitability, investment, and human capital premium. It is observed that among the small portfolios, SHWAH reports the highest mean value of 0.022 with the highest standard deviation value of 1.244. Similarly, SHWCH reports the second-highest mean value of 0.031 with a standard deviation value of 0.161. Moreover, among these portfolios, BLWCL reports the lowest mean value with the lowest standard deviation value of 0.059. Furthermore, among the significant portfolios, BHRAL reports the highest mean value of 0.042 with a standard deviation of 0.177. This association supports the proposition that the higher the risk, the higher the return". Moreover, among all portfolios big portfolio provides higher returns than small portfolios.

Table 2. Descriptive Statistics of Portfolio

P	Mean	SD	Min	Max	Obs
SLWCL	0.004	0.014	-0.178	0.094	3237
SLWCH	0.013	0.047	-0.135	0.234	3237
SLWAL	0.006	0.017	-0.162	0.225	3237
SLWAH	0.004	0.016	-0.143	0.210	3237
SLRCL	0.005	0.015	-0.153	0.406	3237
SLRCH	0.005	0.018	-0.138	0.558	3237
SLRAL	0.003	0.016	-0.150	0.128	3237
SLRAH	0.008	0.030	-0.193	1.368	3237
SHWCL	0.012	0.111	-0.127	2.046	3237
SHWCH	0.031	0.161	-0.161	1.995	3237
SHWAL	0.007	0.016	-0.131	0.557	3237
SHWAH	0.022	1.244	-0.116	7.804	3237

SHRCL	0.003	0.014	-0.194	0.098	3237
SHRCH	0.003	0.016	-0.151	0.354	3237
SHRAL	0.045	0.018	-0.084	0.577	3237
SHRAH	0.006	0.013	-0.188	0.081	3237
BLWCL	0.001	0.059	-0.131	3.314	3237
BLWCH	0.006	0.016	-0.139	0.278	3237
BLWAL	0.007	0.014	-0.072	0.088	3237
BLWAH	0.006	0.012	-0.129	0.075	3237
BLRCL	0.009	0.012	-0.127	0.091	3237
BLRCH	0.007	0.014	-0.106	0.186	3237
BLRAL	0.015	0.057	-0.145	3.158	3237
BLRAH	0.071	0.016	-0.172	0.097	3237
BHWCL	0.010	0.095	-0.184	1.982	3237
BHWCH	0.008	0.081	-0.166	1.691	3237
BHWAL	0.003	0.072	-0.150	3.146	3237
BHWAH	0.007	0.016	-0.118	0.178	3237
BHRCL	0.077	0.073	-0.162	1.085	3237
BHRCH	0.003	0.046	-0.128	0.729	3237
BHRAL	0.042	0.177	-0.254	2.304	3237
BHRAH	0.009	0.085	-0.148	1.636	3237

Note: SD shows the standard deviation, max and min show the maximum and minimum values of the data, and Obs shows the number of observations. Where S and B stand for small and big companies, respectively, L and H denote a company with a low and high book-to-market ratio. R and W represent companies with weak and robust profitability. C and A refer to companies with Conservative and Aggressive investment strategies. L and H show companies with low and higher labor income growth rates, respectively.

Table 3 shows the summary statistics of the risk factors. Among these factors, market size, investment, and human capital premium report the negative mean value, while value premium reports the highest mean values, followed by profitability. More specifically, the negative mean value of MKT is in line with the findings of Sadhwani et al. (2019), who remarked that a negative mean of MKT with a low standard deviation value indicates that volatility in returns is very high. Additionally, the author also remarked that the negative value of the market premium indicates that investors did not receive compensation for bearing market risk, and this could be attributed to periods of economic downturns and crises, where stock returns were lower than the risk-free rate on average.

Table 3. Descriptive Statistics of Risk Factors

Factor	Mean	SD	Min	Max	Obs
MKT	-0.096	0.037	-0.193	0.109	3237
SMB	-0.005	0.079	-0.375	4.420	3237
HML	0.010	0.095	-0.208	1.967	3237
RMW	0.003	0.014	-0.202	0.074	3237
CMA	-0.001	0.016	-0.089	0.201	3237
LBR	-0.001	0.017	-0.280	0.203	3237

Note: SD shows the standard deviation, while max and min show the maximum and minimum values of the data.

Table 4 shows the correlation matrix of the study. It is observed that value, profitability, and investment premium show a negative correlation with market premium, while human capital shows a positive correlation. Further, the relatively low correlations between most factors suggest that they capture distinct sources of risk, enhancing the multi-factor model's explanatory power. For instance, the correlation between market risk premium and size factor is nearly zero, implying that small-cap stocks do not systematically move with market excess returns. Similarly, the low correlation between the market and value premium suggests that the value factor does not strongly co-move with the market.

Moreover, profitability and investment premiums exhibit a significant negative correlation. This inverse relationship suggests that firms with higher profitability tend to invest conservatively, supporting the findings of Fama and French (2015). Similarly, human capital premium is negatively correlated with profitability and positively correlated with investment, indicating that firms with higher labor premiums exhibit different profitability and investment characteristics. These findings align with prior research suggesting that human capital-intensive firms may experience different risk-return trade-offs compared to traditional financial risk factors.

Given the presence of correlations, particularly between factors, we acknowledge the potential for multicollinearity concerns in our study. To mitigate this, we conduct variance inflation factor (VIF) tests to ensure that the factor loadings remain stable and reliable. Additionally, we reference asset pricing literature, for example, Hou et al. (2015), who consider a correlation threshold of 0.8 indicative of redundancy concerns. Since none of our factor correlations exceed this threshold, we argue that multicollinearity is unlikely to distort our regression estimates significantly.

Table 4. Correlation Matrix

	MKT	SMB	HML	RMW	CMA	LBR	VIF
MKT	1						
SMB	0.018	1					1.001
HML	-0.050	-0.010	1				1.023
RMW	-0.006	-0.019	0.084	1			1.506
CMA	-0.015	0.023	-0.085	-0.526	1		1.471
LBR	0.017	-0.010	-0.084	-0.437	0.415	1	1.317

4.1 Human Capital Base Six-Factor Model

Table 5 shows the regression output of the augmented human capital base six-factor model. Findings observed that the market premium is significant at 1% for all of the portfolios (small and big), suggesting that the premium has a positive and significant association with excess portfolio returns. Similarly, we find the coefficient of size premium is positive and significant for small portfolios (SLWCH, SHWAH) at 5 and 1% levels, respectively. In contrast, the size coefficient of significant portfolios (BLWCL, BLRAL, BHWAL, BHRCL, BHRCH, BHRAL, and BHRAH) is negative and significant at 1, 5, and 10%, respectively. Such findings indicate that the size premium has a positive, negative, and significant association with excess return in the Brazilian stock market. Moreover, we find the positive and significant value of value premium for small and big portfolios (SHWCH, SHWAH, BLWCH, BLWAL, BLWAH, BLRCL, and BHWCH); these findings indicate that value premium has a significant impact on excess returns. Whereas for profitability portfolios, we find that small and big portfolios (SLWCL, SLWAL, SLRCL, SHWAH, SHRCH, SHRAH, BLWCL, BLWCH, BLWAL, BLWAH, BLRCL, BLRCH, BHWCL, BHWAL, and BHRCL) have a positive, negative, and significant association with excess portfolio returns. For investment portfolios, we observe that the coefficient of small and big portfolios (SLWAH, SHWCL, SHWCH, SHWAH, SHRCL, SHRAH, BLWCL, BLWCH, BLWAL, BLRCL, BLRCH, BLRAL, BHWCL, BHWCH, BHRAL, and BHRAH) has a positive and significant association with excess portfolio returns. Similarly, for human capital portfolios, we find that small and big portfolios SLRAL, SHRAL, SHRAH, BLWCL, BLWCH, BLWAL, BLRCL, BLRCH, BLRAL, BHWCL, BHRCL, and BHRAH) has a significant positive and negative impact on excess portfolio return.

Table 5. Human Capital-Based Six-Factor Model (Full Sample)

P	Intercept	MKT	SMB	HML	RMW	CMA	LBR	Adj-R2	F-stat
SLWCL	-0.014	0.842	0.002	-0.005	-0.135	0.015	-0.034	0.713	1340.974***
	(-15.329)***	(89.265) ***	(0.479)	(-1.358)	(-4.497)***	(0.573)	(-1.432)		
SLWCH	0.025	1.125	0.021	0.003	-0.099	0.084	-0.031	0.422	394.9347***
	(10.567)***	(48.477) ***	(1.980)**	(0.389)	(-1.347)	(1.286)	(-0.531)		
SLWAL	-0.013	0.853	0.000	-0.004	-0.099	-0.042	0.021	0.674	1118.948***
	(-12.671) ***	(81.568) ***	(0.060)	(-1.026)	(-2.974)**	(-1.421)	(0.808)		
SLWAH	-0.016	0.830	-0.000	-0.005	-0.051	-0.087	0.024	0.673	1114.596***
	(-15.24)***	(81.393) ***	(-0.110)	(-1.306)	(-1.574)	(-3.040)***	(0.932)		
SLRCL	-0.014	0.843	0.004	-0.006	-0.106	-0.028	-0.001	0.695	1230.251***
	(-14.433) ***	(85.499) ***	(0.913)	(-1.572)	(-3.380)***	(-1.004)	(-0.050)		
SLRCH	-0.014	0.843	0.004	-0.004	0.010	0.016	-0.013	0.650	1004.493***
	(-13.141) ***	(77.411) ***	(0.797)	(-1.146)	(0.302)	(0.529)	(-0.483)		
SLRAL	-0.013	0.860	0.001	-0.001	0.006	-0.018	0.059	0.693	1220.306***
	(-12.778)	(85.278) ***	(0.235)	(-0.422)	(0.190)	(-0.653)	(2.313)**		
SLRAH	-0.014	0.840	0.009	-0.007	0.0446	0.006	0.054	0.481	502.647***
	(-9.320) ***	(54.655) ***	(1.257)	(-1.193)	(0.909)	(0.159)	(1.407)		
SHWCL	0.036	1.252	-0.033	0.005	-0.244	-0.253	-0.061	0.149	95.551***
	(6.776) ***	(23.768) ***	(-1.327)	(0.026)	(-1.452)	(-1.697)*	(-0.458)		
SHWCH	-0.005	0.705	0.032	0.872	-0.232	0.377	0.163	0.273	204.442***
	(-0.885)	(10.848) ***	(1.063)	(33.787)***	(-1.120)	(2.050)**	(0.991)		
SHWAL	-0.014	0.841	0.001	-0.003	-0.012	0.030	-0.020	0.677	1132.675***
	(-13.961) ***	(82.244) ***	0.290	(-0.764)	(-0.375)	(1.065)	(-0.787)		
SHWAH	-0.002	0.665	15.44	0.102	-0.768	-0.603	0.748	0.965	14876.06***
	(-0.200)	(6.120) ***	(298.34)***	(2.372)**	(-2.215)**	(-1.959)*	(2.709)***		
SHRCL	-0.015	0.837	-0.000	-0.005	-0.036	0.100	-0.021	0.722	1404.287***
	(-16.731) ***	(91.440) ***	(-0.147)	(-1.556)	(-1.254)	(3.890)**	(-0.933)		
SHRCH	-0.0142	0.850	0.001	-0.004	-0.096	0.003	-0.040	0.697	1247.114***
	(-14.025) ***	(86.198) ***	(0.308)	(-1.116)	(-3.054)***	(0.107)	(-1.597)		
SHRAL	-0.0162	0.828	0.002	-0.004	-0.025	0.033	-0.055	0.643	975.736***
	(-14.535) ***	(76.308) ***	(0.457)	(-1.137)	(-0.736)	(1.098)	(-2.020)**		
SHRAH	-0.014	0.848	0.003	-0.0043	-0.082	0.042	-0.065	0.735	1498.325***
	(-16.046) ***	(94.516) ***	(0.007)	(-1.229)	(-2.887)***	(1.664)*	(-2.867)***		
BLWCL	-0.014	0.825	-0.038	-0.014	-0.931	0.584	0.496	0.342	281.682***
	(-5.554) ***	(31.605) ***	(-3.056)***	(-1.408)	(-11.173)***	(7.900)**	(7.483)***		
BLWCH	-0.014	0.840	-0.004	-0.008	-0.364	0.252	-0.834	0.796	2109.836***
	(-17.933) ***	(105.230) ***	(-1.085)	(-2.527)***	(-14.294)***	(11.178)***	(-41.140)***		
BLWAL	-0.014	0.840	-0.004	-0.008	-0.3691	-0.748	0.169	0.791	2044.257***
	(-17.774) ***	(104.506) ***	(-1.132)	(-2.539)**	(-14.384)***	(-32.875)***	(8.282)***		
BLWAH	-0.014	0.844	0.007	-0.006	-0.062	-0.006	0.027	0.746	1589.325***
	(-16.466) ***	(97.232) ***	(0.171)	(-1.760)*	(-2.243)**	(-0.245)	(1.248)		
BLRCL	-0.014	0.841	-0.004	-0.007	0.632	0.253	0.166	0.783	1952.338***
	(-17.847) ***	(105.235) ***	(-1.115)	(-2.497)**	(24.803)***	(11.181)***	(8.201)***		
BLRCH	-0.015	0.835	0.003	-0.005	-0.059	-0.077	0.074	0.705	1291.526***
	(-15.509) ***	(87.51) ***	(0.071)	(-1.559)	(-1.956)**	(-2.853)***	(3.088)***		
BLRAL	-0.016	0.818	-0.059	-0.015	-0.118	-0.147	0.153	0.223	156.134***
	(-5.678) ***	(29.927) ***	(-4.542)***	(-1.417)	(-1.353)	(-1.899)*	(2.204)**		
BLRAH	-0.014	0.847	0.006	-0.005	-0.049	0.022	0.009	0.696	1238.211***
	(-13.926) ***	(85.879) ***	(0.014)	(-1.435)	(-1.577)	(0.787)	(0.377)		
BHWCL	-0.014	0.841	-0.004	0.991	-0.366	0.252	0.166	0.970	17455.86***

P	Intercept	MKT	SMB	HML	RMW	CMA	LBR	Adj-R2	F-stat
	(-17.781) ***	(104.813) ***	(-1.091)	(311.04)	(-14.311)***	(11.102)***	(8.163)***		
BHWCH	0.007	0.991	-0.007	0.058	0.109	0.224	-0.150	0.169	111.301***
	(1.756)*	(25.666) ***	(-0.421)	(3.817)**	(0.891)	(2.056)**	(-1.537)		
BHWAL	-0.0146	0.814	-0.088	-0.018	-0.190	-0.115	0.097	0.155	100.4293
	(-4.140) ***	(23.704) ***	(-5.382)***	(-1.338)	(-1.735)*	(-1.186)	(1.119)		
BHWAH	-0.015	0.836	-0.007	-0.003	0.035	0.040	0.036	0.686	1181.798***
	(-14.913) ***	(83.966) ***	(-0.162)	(-0.852)	(1.120)	(1.427)	(1.424)		
BHRCL	-0.017	0.739	-0.051	-0.019	0.246	-0.056	0.167	0.126	79.098***
	(-4.865) ***	(21.235) ***	(-3.082)***	(-1.413)	(2.219)**	(-0.571)	(1.892)*		
BHRCH	-0.009	0.861	-0.02	-0.003	-0.068	0.021	0.001	0.308	242.0549
	(-4.259) ***	(37.967) ***	(-2.096)**	(-0.336)	(-0.941)	(0.337)	(0.024)		
BHRAL	0.087	1.469	-0.192	-0.020	-0.238	-0.530	-0.058	0.095	58.217***
	(10.272) ***	(17.828) ***	(-4.898)***	(-0.616)	(-0.908)	(-2.275)**	(-0.280)		
BHRAH	-0.026	0.622	-0.03	0.007	-0.136	-0.291	0.205	0.072	42.892***
	(-6.530) ***	(15.580) ***	(-1.6147)*	(0.498)	(-1.072)	(-2.575)**	(2.024)**		

*Note: The value in parentheses shows t statistics, and *'**'*** shows the significance level at 10, 5, and 1%, respectively.* Moreover, we use the data from July 2010 to June 2023 for complete sample analysis.

4.2 Performance of Human Capital Based Six Factor Model during Crisis and COVID-19

Tables A1 and A2 (see the appendix) show the model's performance before and during the Brazilian economic crisis. The estimation output shows that before and during the crisis, the market premium has a positive and significant relationship with excess portfolio returns. Surprisingly, the size premium significantly explains the association with portfolio returns during crisis, while we report a less pronounced effect of size on returns before crisis periods. Similarly, the value premium has a nuanced effect on portfolio returns during crisis periods. On the other hand, we report that the effect of profitability premium on portfolio returns was significantly improved during the crisis period, while investment and labor income growth premium reports a less nuanced effect on portfolio returns during crisis periods. Similarly, smaller firms are often perceived as riskier and may experience heightened risk premia due to their lower liquidity and limited access to financing. Smaller firms typically have higher leverage, greater default risk, and lower liquidity, making them particularly vulnerable to economic downturns. Consequently, investors demand a higher risk premium for holding small-cap stocks during crises. Firms with strong profitability tend to have better cash flow management, lower default risk, and greater resilience to adverse economic shocks, which makes them more attractive to investors seeking stability in turbulent times. This observation aligns with asset pricing models, such as those proposed by Fama and French (2015), highlighting profitability as a key determinant of firm valuation, mainly when high uncertainty is high.

On the other hand, the human capital factor appears to be less nuanced in response to crises. Its nature is an intangible, long-term characteristic influencing firm productivity over extended horizons rather than reacting to short-term market shocks. Firms may adjust hiring and wages during downturns, but the overall contribution of human capital to firm value remains more stable compared to traditional financial risk factors. Additionally, the pricing of human capital risk may be less directly tied to market-wide risk aversion, as investors often prioritize more tangible financial indicators when assessing risk during crisis periods.

Similarly, Tables A3, A4, and A5 (see appendix) show the model's performance after the economic crisis, during COVID-19, and post-pandemic periods. It is observed that the performance of six-factor models significantly improved in COVID-19, explaining the variability in portfolio returns. Furthermore, we find that among other factors (size, value, profitability, and investment), market premium positively and significantly impacts portfolio returns during both periods (post-crisis and COVID-19). Moreover, Table A6 (see appendix) reports the model's explanatory power during the sample periods. We report that the predictive power of the six-factor model has significantly decreased across the sample period. In contrast, the adjusted R-squared (hereafter Adj-R^2) ranges from 7.21 to 97% in the entire sample. Furthermore, the Adj-R^2 has significantly improved during the crisis and COVID-19; such findings indicate that these risk factors significantly explain the time series variability in portfolio returns. Further, the Ramsey Regression Equation Specification Error Test (RESET) is employed (see Appendix A7) to detect potential misspecifications such as omitted variables or incorrect functional forms. The test results report evidence against the null hypothesis that the model is correctly specified. Moreover, we also employ the test (see Appendix A8) for endogeneity in the relationship between MKT and explanatory variables, namely SMB, HML, RMW, CMA, LBR, and RESID01. The inclusion of RESID01, the residual from the first-stage regression, serves as an endogeneity diagnostic. The coefficient for RESID01 is statistically insignificant, suggesting that endogeneity is not a concern in this model.

Furthermore, Table 6 shows the results of the GRS test (Wald) and GRS-F test, indicating that the null hypothesis of portfolio efficiency is rejected across all periods. Moreover, the GRS statistics are highly significant during the whole sample period, confirming that systematic risks are not entirely captured. Meanwhile, the mean absolute alpha value that is nearest to zero is 0.00457011 (from the pre-crisis period), and the findings suggest that the asset pricing model had the least mispricing errors during this period, meaning it performed relatively better in explaining asset returns before the crisis. Furthermore, these findings align with Fama and French (2015), who concluded that the GRS test quickly rejects FF5FM for capturing these patterns. However, their model explains between 71% and 94% of the cross-sectional variability in asset returns.

Table 6. GRS Test for HC6F Model Performance during Full and Crisis Period Based on GRS F test and Absolute Average Alpha

Period	GRS test (Wald)	GRS-F test	Mean Absolute Alpha
Full sample	32.551***	18.114***	.00928519
Pre-Crisis	15.968***	2.750***	.00457011
During Crisis	10.281***	2.225***	.00776981
Post-Crisis	37.712***	0.7909	.00792701
During COVID-19	4.209***	3.201***	.00959785
Post COVID-19	65.503***	1.93**	.01804227

Note: This table shows the performance of the six-factor model to explain the variability in portfolio returns across the sample period. Where */**/** shows the significance level at 10, 5 and 1% respectively.

Table 7 presents the Fama and Macbeth (1973) rolling window two-pass regression estimation results for the market, size, value, profitability, investment, and labor-income growth rate premiums, with all sub-sorted portfolios as dependent variables. Specifically, we estimate factor loadings for each underlying portfolio, taking a 36-month window. Then, we continue this process by adding the next month and dropping the first month from the estimation window. The results indicate that these factors fail to explain the relationship between risk factors and future portfolio returns in the Brazilian equity market during the study period. Furthermore, the factor loadings are statistically significant and insignificant across all portfolios in the two-pass regression. Consequently, it is concluded that the risk premiums of these factors do not account for future portfolio returns. Additionally, the model exhibits low explanatory power for all portfolios, suggesting that past betas cannot predict returns. These findings support the notion of Zada et al. (2018) and Khan et al. (2022), who remarked that past beta fails to predict variability in excess portfolio returns in emerging economies accurately.

Table 7. Fama and Macbeth Rolling Window Two-Pass Regression

	Intercept	MKT	SMB	HML	RMW	CMA	LBR	Adj-R^2
SLWCL	-0.09769	0.0070	0.0023	-0.0037	-0.0004	0.0177	-0.0003	0.0402
	(-126.348)***	(2.8411)***	(1.4885)	(-1.5464)	(-2.8046)***	(1.7891)	(-1.7953)	
SLWCH	-0.08437	-0.0128	0.0056	0.0209	-0.0006	0.0442	-0.0011	0.0310
	(-61.6293)***	(-2.6546)***	(3.5207)	(1.9615)	(-1.4665)	(1.5109)	(-2.7091)***	
SLWAL	-0.0966	-0.0059	0.0005	-0.0085	-0.0004	0.0186	-0.0002	0.0510
	(-117.528)***	(-2.2713)***	(0.5016)	(-1.6837)	(-2.4210)***	(1.9399)	(-1.6549)	
SLWAH	-0.09638	-0.0093	0.0073	-0.0132	-0.0001	0.0348	-0.0005	0.1249
	(-121.683)***	(-3.4124)***	(4.7557)***	(-1.1901)	(-1.9912)	(15.7516)***	(-4.1667)***	
SLRCL	-0.09463	0.0024	0.0039	0.0314	-0.0002	0.0296	-0.0001	0.0643
	(-128.085)***	(0.8481)	(4.5326)	(1.2078)	(-1.8775)	(1.5776)	(-1.3659)	
SLRCH	-0.09305	0.0083	-0.0088	0.0128	-0.0000	0.0368	-0.0002	0.0669
	(-115.743)***	(3.8030)***	(-1.7944)	(1.2302)	(-0.0258)	(1.7378)	(-2.1348)	
SLRAL	-0.09903	-0.0009	0.0085	-0.0150	-0.0004	0.0132	-0.0007	0.0398
	(-121.407)***	(-0.3597)	(1.8792)	(-1.9446)	(-1.4651)	(4.4449)***	(-3.1235)***	
SLRAH	-0.09717	0.0056	0.0006	-0.0189	-0.0003	0.0122	-0.0004	0.0359
	(-95.6559)***	(3.8380)***	(0.4391)	(-1.4161)	(-2.7437)***	(1.6669)	(-2.4958)***	
SHWCL	-0.09567	-0.0011	-0.0096	-0.0085	-0.0024	-0.0024	-0.0015	0.1219
	(-44.9786)***	(-0.7453)	(-18.737) ***	(-4.7278)***	(-3.4613)***	(-1.2507)	(-2.5397)***	
SHWCH	-0.06866	-0.0007	-0.002	0.0059	-0.0001	0.0044	-0.0004	0.0166
	(-23.2499)***	(-0.5307)	(-1.2246)	(2.0921)**	(-1.6832)	(2.5472)	(-4.6657)***	
SHWAL	-0.09708	0.0011	0.0020	-0.0125	-0.0005	0.0167	-0.0009	0.0254
	(-132.397)***	(0.3384)	(1.2826)	(-1.0700)	(-2.1067)	(1.3196)	(-1.9672)	
SHWAH	-0.07186	-0.0137	-0.1191	0.0144	0.0673	0.0961	0.0978	0.1626
	(-3.32875)***	(-2.6167)***	(-6.1223)***	(0.8440)	(10.3407)***	(11.0918)***	(15.1429)***	
SHRCL	-0.10082	-0.0026	0.0119	-0.0170	-0.0006	0.0039	-0.0008	0.0450
	(-130.109)***	(-0.8926)	(1.5168)	(-1.632)	(-2.1821)	(1.5075)	(-1.7335)	
SHRCH	-0.0982	0.0358	0.0005	0.0115	-0.0006	0.0310	-0.0006	0.1001
	(-136.978)***	(1.0601)	(0.5807)	(3.9800)***	(-4.7688)***	(1.0200)	(-1.2042)	
SHRAL	-0.0958	0.0073	0.0013	0.0194	-0.0008	0.0281	-0.0012	0.0516
	(-126.279)***	(3.0603)***	(1.1777)	(1.4331)	(-1.0578)	(1.8522)	(-1.9088)	
SHRAH	-0.09602	-0.0095	0.0039	0.0273	-0.0006	0.0330	-0.0011	0.0795
	(-136.256)***	(-2.6331)***	(3.8240)***	(1.4177)	(-2.4603)***	(1.5359)	(-4.8441)***	
BLWCL	-0.10005	-0.0515	0.0163	-0.0011	-0.0007	0.0134	-0.0006	0.0681
	(-61.4671)***	(-1.9037)	(1.5394)	(-0.3511)	(-1.4874)	(1.7190)	(-1.5116)	
BLWCH	-0.09314	-0.0170	0.0139	0.0407	-0.0006	0.0429	-0.0009	0.1263
	(-130.707)***	(-1.4110)	(1.0033)	(1.0637)	(-2.5432)***	(1.1480)	(-1.0409)	
BLWAL	-0.09225	-0.0074	0.0149	-0.0263	-0.0006	0.0051	-0.0005	0.0669
	(-74.2269)***	(-2.5549)***	(1.3865)	(-1.2743)	(-1.2510)	(2.5073)***	(-1.3559)	
BLWAH	-0.09709	0.0053	0.0079	-0.0074	-0.0001	0.0158	-0.0004	0.0303
	(-125.541)***	(1.6505)	(1.3702)	(-2.5481)***	(-0.5063)	(1.2978)	(-1.9154)	
BLRCL	-0.09541	-0.0044	0.0115	-0.0137	-0.0004	0.0173	-0.0007	0.0470
	(-129.473)***	(-1.2126)	(1.9789)**	(-4.1485)***	(-1.5366)	(1.1542)	(-2.9492)***	
BLRCH	-0.09474	-0.0142	0.01142	-0.0229	-0.0004	0.0216	-0.0003	0.0948
	(-118.197)***	(-1.2946)	(1.3562)	(-1.3041)	(-1.0380)	(1.2744)	(-1.9013)	
BLRAL	-0.09359	-0.0130	-0.0046	0.0142	-0.0006	0.0147	-0.0005	0.0123
	(-75.967)***	(-1.7873)	(-1.1674)	(1.0504)	(-2.6552)***	(1.8132)	(-2.0733)	
BLRAH	-0.09792	0.0100	-0.0007	-0.0065	-0.0003	0.0149	-0.0006	0.0282
	(-127.305)***	(1.3898)	(-0.5236)	(-2.8336)***	(-1.1870)	(1.2945)	(-2.7625)***	
BHWCL	-0.0951	0.0019	-0.0017	0.0102	-0.0000	0.0064	-0.0000	0.0139

	Intercept	MKT	SMB	HML	RMW	CMA	LBR	Adj-R²
	(-30.2775)***	1.1620	(-1.1415)	(2.0042)**	(-0.0743)	(3.4261)***	(-0.4753)	
BHWCH	-0.09798	0.0013	-0.0059	0.0015	0.0000	0.0011	-0.0005	0.0704
	(-57.0282)***	(0.9942)	(-1.669)	(0.5334)	(0.0798)	(0.6759)	(-1.6327)	
BHWAL	-0.09429	-0.0076	-0.0049	-0.0014	-0.0012	0.0162	-0.0015	0.0160
	(-65.0473)***	(-2.4423)***	(-1.1027)	(-0.4249)	(-2.1663)***	(4.8602)***	(-3.1001)***	
BHWAH	-0.09634	0.0336	-0.0015	0.0174	-0.0001	0.0235	-0.0004	0.0653
	(-142.026)***	(1.1864)	(-2.5912)***	(5.8998)***	(-0.8361)	(7.5408)***	(-3.7176)***	
BHRCL	-0.09051	0.0077	-0.0016	0.0006	-0.0002	-0.0070	-0.0007	0.0168
	(-54.807)***	(2.5468)***	(-3.2490)***	(0.3184)	(-0.7955)	(-3.9200)***	(-3.1359)***	
BHRCH	-0.09645	0.0005	-0.0041	-0.0055	-0.0005	0.0133	-0.0008	0.0690
	(-90.8364)***	(0.3348)	(-1.1960)	(-2.5894)***	(-2.7828)***	(4.8836)***	(-4.4423)***	
BHRAL	-0.09758	0.0022	-0.0082	-0.0032	-0.0015	-0.0011	0.0003	0.1109
	(-25.4503)***	(1.5766)	(-1.8429)	(-2.0301)***	(-2.3094)***	(-0.6808)	(0.6564)	
BHRAH	-0.08873	-0.0016	-0.0023	-0.0064	-0.0001	0.0025	-0.0000	0.0076
	(-52.4675)***	(-0.9657)	(-3.2501)***	(-2.5445)***	(-0.9849)	(1.1284)	(-0.9013)	

Note: The value in parentheses shows t-statistics, and */**/*** shows the significance level at 10, 5, and 1%, respectively. Moreover, we use the data from July 2010 to June 2023 for complete sample analysis.

5. Discussion

The findings of our study are in line with those of previous studies. First, findings support the theoretical notion of Markowitz (1952), who documented that a portfolio with a maximum level of returns and minimum level of variance is considered efficient. Following Sharpe (1964), Lintner (1965), and Mossin (1966), findings report that the market premium significantly priced the time series variability in asset returns. Furthermore, we document that FF3FM and FF5FM factors significantly capture the risk exposure in portfolio returns. Similarly, González-Sánchez (2022) concluded that portfolios in SDF models show better goodness of fit, as compared to the factorial model. Furthermore, they document that value and growth stocks perform well in emerging markets. Moreover, Kolari et al. (2022) compare the performance of ZCAPM with traditional asset pricing models (CAPM, FF3FM, C4FM). Using the global sample, the authors find that out of the sample, the ZCAPM outperforms the three and four-factor models in terms of returns dispersion. Nettayanun (2023) reported that the q-factor model performs well overall and in bull markets, while FF6FM performs well in bear markets. Liu (2023) documents that CAPM, FF3FM, and FF5FM significantly explain time series variability in excess portfolio returns during the COVID-19 pandemic. More specifically, our findings align with the outcome of Sitanggang and Rizkianto (2024), who reported that market size, value, and profitability premium have insignificant effects on excess portfolio returns during COVID-19. Zhou et al. (2024) document that COVID-19 has significantly affected the stock return, while the performance of Fama and French models during COVID-19 was decreased, to explain the variability in excess portfolio returns. Kausar et al. (2024) document that firms with high IR report lower returns than firms with low IR. For human capital, the findings align with some of the earlier studies; for instance, a growing body of literature reports that human capital (proxy by salaries and wages) accurately predicts time series variability in asset returns. In emerging markets, portfolios with low labor income growth rates outperform portfolios with high labor income growth rates (Khan et al., 2022; Khan et al., 2023; Prasad et al., 2024; Roy & Shijin, 2018).

6. Conclusion

Markowitz's modern portfolio theory (1952) has garnered the attention of researchers worldwide to examine the relationship between risk and return. However, the seminal work of Sharpe (1964), Mossin (1964), and Lintner (1965) has marked the beginning of asset pricing models. Over the past few decades, researchers have used the CAPM to understand the nuanced relationship between risk and return. In addition, several studies challenge the assumptions of CAPM to explain the variability in asset returns. To overcome this issue, many researchers proposed multifactor asset pricing models to explain the variability in asset returns. Moreover, the performance of these models in economic and financial crises, geopolitical tension, invasion, and pandemics has remained scarce to investigate. Therefore, this study aims to test the applicability and validity of the augmented human capital-based six-factor assets pricing model in the Brazilian economy. To do this, first, we take daily data of stocks listed on the Bovespa index for the period spanning from July 2010 to June 2023. Second, we take yearly balance sheet data for portfolio constructions from 2010 to 2022. Third, we construct 32 portfolios following Fama and French's (2015) portfolio construction methodology. Fourth, to test the performance of asset pricing models, we split the sample data into the following sections: full sample, pre-crisis, during crisis, post-crisis, during COVID-19, and post-COVID-19.

Employing the Fama and MacBeth (1973) two-step estimation approach, findings indicate that the Brazilian crisis and COVID-19 have created identical volatility in Brazil's stock market, in response to which most portfolios show inefficient returns with higher risk. For instance, among 32 portfolios, small portfolios report considerably higher returns along with a higher risk value than large portfolios. Furthermore, we find that the market premium significantly explains the time series variability in all sets of portfolios. For size, value, profitability, investment, and human capital, we find significant relationships between these factors and excess portfolio returns, which means that these factors are significantly priced in Brazilian stock markets. Furthermore, we find that the Mean Absolute Alpha value is nearest to zero in the pre-crisis period, and the findings suggest that the asset pricing model had the least mispricing errors during this period, meaning it performed relatively better in explaining asset returns before the crisis.

The findings of our study provide important implications for investors and portfolio managers to consider the exposure of these risk factors when designing portfolios for investment. Additionally, this study offers several insights for investors, portfolio managers, and policymakers by highlighting the impact of economic crises and the COVID-19 pandemic on the Brazilian stock market. First, investors and portfolio managers should consider increasing allocations to larger, more stable firms during periods of economic distress, as small portfolios exhibit higher risk and inefficiency. Additionally, incorporating human capital factors into investment decisions is important, as labor income growth rates significantly affect asset returns. Further, investors must focus on firms with substantial human capital development, stable employment growth, and high labor productivity. More specifically, adopting factor-based investment strategies that account for size, value, profitability, and investment factors alongside market risk can help mitigate risk exposure and improve portfolio performance. For policymakers, however, the results emphasize the necessity of targeted interventions to stabilize financial markets during crises.

Moreover, our study extends the FF5FM with an additional factor, human capital, and we find that the labor income growth rate significantly prices the variability in asset returns. Following this, our study also suggests that investors should consider the investment in human capital in Brazilian companies when using fundamental and technical analysis. Further, future research can extend the applicability of the human capital-based six-factor model by examining its relevance in other emerging markets. Additionally, incorporating new anomalies such as the ESG premium and uncertainty premium could enhance the explanatory power of asset pricing models, particularly during periods of financial distress. Alternative estimation techniques, such as the Fama and MacBeth (1973) two-pass (cross-sectional) regression or the generalized method of moments (GMM), can also be employed to validate the findings and improve the accuracy of factor pricing.

Supplementary Materials: Additional materials, such as datasets and the portfolio formation technique employed in this study, will be available upon request.

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Appendix

Table A1 Model Performance Pre-Economic Crisis

P	Intercept	MKT	SMB	HML	RMW	CMA	LBR	Adj-R^2	F-stat
SLWCL	-0.035	0.648	0.001	-0.004	-0.049	-0.052	-0.081	0.511	183.930
	(-17.226)***	(32.973)***	(0.214)	(-0.216)	(-1.212)	(-1.206)	(-2.081)**		
SLWCH	-0.033	0.667	0.001	0.005	0.022	0.063	-0.075	0.535	201.828
	(-16.492)***	(34.670)***	(0.329)	(0.273)	(0.545)	(1.509)	(-1.989)**		
SLWAL	-0.034	0.656	-0.002	0.001	0.014	0.097	-0.086	0.443	139.962
	(-14.610)***	(28.892)***	(-0.553)	(0.057)	(0.296)	(1.958)*	(-1.914)*		
SLWAH	-0.039	0.619	-0.002	-0.004	0.105	0.094	-0.134	0.393	114.007
	(-15.670)***	(25.768)***	(-0.492)	(-0.199)	(2.128)**	(1.794)*	(-2.819)**		
SLRCL	-0.034	0.651	0.002	-0.012	-0.053	0.026	-0.163	0.335	89.034
	(-11.658)***	(22.833)***	(0.522)	(-0.460)	(-0.913)	(0.411)	(-2.897)**		
SLRCH	-0.032	0.686	-0.002	-0.032	-0.017	0.019	-0.171	0.437	136.903
	(-12.570)***	(28.300)***	(-0.429)	(-1.423)	(-0.347)	(0.354)	(-3.584)***		
SLRAL	-0.033	0.674	0.000	-0.020	0.028	-0.015	-0.077	0.482	163.696
	(-14.678)***	(31.104)***	(-0.008)	(-0.996)	(0.619)	(-0.313)	(-1.806)*		
SLRAH	-0.035	0.659	-0.003	0.016	-0.028	-0.053	-0.063	0.425	130.022
	(-14.026)***	(27.766)***	(-0.792)	(0.707)	(-0.574)	(-1.013)	(-1.337)		
SHWCL	-0.039	0.583	-0.004	0.218	0.041	0.117	-0.019	0.112	23.064
	(-7.105)***	(10.934)***	(-0.437)	(4.392)***	(0.371)	(1.004)	(-0.183)		
SHWCH	-0.015	0.793	-0.001	-0.025	0.246	0.131	0.011	0.247	58.446
	(-3.454)***	(18.477)***	(-0.081)	(-0.625)	(2.787)**	(1.397)	(0.131)		
SHWAL	-0.034	0.657	(0.000	-0.036	0.126	-0.056	-0.002	0.295	74.020
	(-10.431)***	(20.741)***	(0.082)	(-1.226)	(1.936)*	(-0.811)	(-0.025)		
SHWAH	-0.021	0.679	15.938	0.648	-1.184	2.314	1.660	0.996	45979.329
	(-1.088)	(3.624)***	(523.245)***	(3.706)***	(-3.077)***	(5.653)***	(4.490)***		
SHRCL	-0.033	0.670	-0.002	-0.015	0.043	0.065	-0.066	0.468	154.717
	(-14.327)***	(30.364)***	(-0.484)	(-0.739)	(0.953)	(1.354)	(-1.526)		
SHRCH	-0.032	0.677	-0.001	-0.013	-0.069	-0.037	-0.216	0.406	120.654
	(-12.086)***	(26.314)***	(-0.234)	(-0.545)	(-1.308)	(-0.658)	(-4.250)***		
SHRAL	-0.031	0.685	0.000	-0.041	0.040	0.106	-0.281	0.272	66.463
	(-8.483)***	(19.375)***	(0.002)	(-1.243)	(0.554)	(1.369)	(-4.031)***		
SHRAH	-0.034	0.663	-0.001	-0.034	-0.036	-0.023	-0.176	0.416	125.500
	(-13.339)***	(26.977)***	(-0.138)	(-1.487)	(-0.706)	(-0.431)	(-3.624)***		
BLWCL	-0.040	0.574	-0.040	-0.366	-1.679	1.604	1.219	0.329	86.655
	(-3.239))***	(4.826)***	(-2.050)**	(-3.301)***	(-6.877)***	(6.177)***	(5.199)***		
BLWCH	-0.036	0.643	-0.003	-0.041	-0.182	0.380	-0.886	0.608	272.557

P	Intercept	MKT	SMB	HML	RMW	CMA	LBR	Adj-R^2	F-stat
	(-17.653)***	(33.095)***	(-0.894)	(-2.287)**	(-4.558)***	(8.962)***	(-23.138)***		
BLWAL	-0.035	0.644	-0.003	-0.045	-0.196	-0.631	0.132	0.546	211.317
	(-16.954)***	(32.031)***	(-0.928)	(-2.399)**	(-4.748)***	(-14.378)***	(3.322)***		
BLWAH	-0.035	0.655	0.001	-0.017	-0.021	0.039	-0.133	0.497	173.764
	(-16.306)***	(32.016)***	(0.426)	(-0.893)	(-0.509)	(0.877)	(-3.306)***		
BLRCL	-0.035	0.650	-0.003	-0.039	0.809	0.381	0.119	0.589	251.756
	(-17.189)***	(33.153)***	(-0.933)	(-2.146)**	(20.096)***	(8.905)***	(3.074)***		
BLRCH	-0.035	0.656	0.001	0.008	0.082	0.014	-0.008	0.447	142.330
	(-14.837)***	(29.064)***	(0.346)	(0.381)	(1.780)*	(0.292)	(-0.190)		
BLRAL	-0.035	0.654	0.000	-0.018	0.025	0.049	-0.058	0.472	157.064
	(-15.702)***	(30.593)***	(-0.039)	(-0.880)	(0.563)	(1.042)	(-1.372)		
BLRAH	-0.034	0.664	0.001	-0.021	0.076	0.086	-0.102	0.438	137.498
	(-13.891)***	(28.471)***	(0.348)	(-0.952)	(1.581)	(1.686)*	(-2.224)**		
BHWCL	-0.035	0.647	-0.003	0.954	-0.188	0.375	0.117	0.776	605.478
	(-16.984)***	(32.552)***	(-0.896)	(51.433)***	(-4.599)***	(8.631)***	(2.994)***		
BHWCH	-0.032	0.670	0.007	-0.005	-0.041	-0.029	-0.038	0.263	63.461
	(-8.955)***	(19.352)***	(1.296)	(-0.143)	(-0.583)	(-0.384)	(-0.550)		
BHWAL	-0.034	0.658	-0.003	-0.028	-0.066	-0.047	-0.109	0.411	122.800
	(-13.409)***	(26.908)***	(-0.694)	(-1.219)	(-1.312)	(-0.874)	(-2.265)**		
BHWAH	-0.036	0.638	-0.001	-0.003	0.140	0.162	-0.096	0.274	67.133
	(-10.642)***	(19.834)***	(-0.220)	(-0.084)	(2.125)**	(2.303)***	(-1.508)		
BHRCL	-0.035	0.619	0.006	0.008	0.457	0.340	-0.048	0.143	30.152
	(-6.876)***	(12.487)***	(0.742)	(0.171)	(4.485)***	(3.137)***	(-0.488)		
BHRCH	0.006	0.965	-0.026	0.151	0.025	0.010	0.124	0.066	13.266
	(0.522)	(8.750)***	(-1.441)	(1.471)	(0.110)	(0.040)	(0.570)		
BHRAL	-0.030	0.688	-0.005	0.142	0.026	0.105	-0.090	0.366	102.137
	(-10.183)***	(24.119)***	(-1.059)	(5.325)***	(0.436)	(1.688)*	(-1.591)		
BHRAH	-0.036	0.645	-0.005	-0.031	-0.039	-0.041	-0.082	0.470	156.103
	(-16.212)***	(30.400)***	(-1.547)	(-1.560)	(-0.893)	(-0.880)	(-1.950)**		

Note: The value in parentheses shows the t-statistics, and */**/*** shows the significance levels at 10, 5, and 1%, respectively. Moreover, for pre-crisis analysis, we use data from June 2010 to August 2014.

Table A2. Model Performance During Economic Crisis

P	Intercept	MKT	SMB	HML	RMW	CMA	LBR	Adj-R^2	F-stat
SLWCL	-0.031	0.745	0.049	-0.306	-0.112	0.032	-0.046	0.542	162.996
	(-9.991)***	(30.150)***	(1.115)	(-4.702)***	(-1.867)*	(0.599)	(-1.227)		
SLWCH	-0.027	0.774	0.054	-0.119	-0.175	-0.026	-0.023	0.556	172.415
	(-8.904)***	(31.754)***	(1.243)	(-1.854)*	(-2.959)***	(-0.491)	(-0.625)		
SLWAL	-0.030	0.749	0.072	-0.186	-0.174	0.000	-0.025	0.518	147.858
	(-9.345)***	(29.085)***	(1.565)	(-2.733)***	(-2.774)***	(-0.005)	(-0.631)		
SLWAH	-0.033	0.721	0.026	-0.166	-0.146	-0.146	0.040	0.481	127.963
	(-9.927)***	(27.341)***	(0.549)	(-2.384)***	(-2.274)***	(-2.582)**	(1.001)		
SLRCL	-0.031	0.745	0.082	-0.193	-0.134	-0.036	0.017	0.570	182.300
	(-10.731)***	(32.443)***	(2.002)**	(-3.185)***	(-2.408)***	(-0.726)	(0.489)		
SLRCH	-0.032	0.726	0.051	-0.092	-0.003	0.040	0.021	0.461	118.101
	(-9.421)***	(26.485)***	(1.048)	(-1.275)	(-0.051)	(0.678)	(0.489)		
SLRAL	-0.032	0.741	-0.020	-0.174	-0.106	-0.022	0.014	0.542	162.924
	(-10.588)***	(30.805)***	(-0.474)	(-2.738)***	(-1.820)*	(-0.417)	(0.374)		
SLRAH	-0.032	0.726	0.114	-0.102	-0.101	0.083	-0.006	0.441	108.916

P	Intercept	MKT	SMB	HML	RMW	CMA	LBR	Adj-R²	F-stat
	(-8.985)***	(25.098)***	(2.214)**	(-1.343)	(-1.440)	(1.334)	(-0.146)		
SHWCL	-0.030	0.748	0.043	-0.090	-0.112	-0.011	-0.041	0.516	146.809
	(-9.586)***	(29.495)***	(0.963)	(-1.340)	(-1.817)*	(-0.200)	(-1.048)		
SHWCH	0.001	0.745	-0.852	-0.289	-0.671	-0.370	0.310	0.025	4.546
	(0.033)	(3.821)***	(-2.459)**	(-0.563)	(-1.415)	(-0.883)	(1.038)		
SHWAL	-0.032	0.733	0.050	-0.222	-0.039	-0.004	-0.052	0.524	151.623
	(-10.400)***	(29.764)***	(1.132)	(-3.422)***	(-0.643)	(-0.082)	(-1.375)		
SHWAH	-0.034	0.719	0.029	-0.168	-0.010	-0.010	-0.034	0.485	130.075
	(-10.514)***	(27.757)***	(0.623)	(-2.465)***	(-0.165)	(-0.172)	(-0.848)		
SHRCL	-0.035	0.719	-0.005	-0.294	-0.044	0.027	-0.068	0.567	180.365
	(-12.340)***	(32.024)***	(-0.119)	(-4.965)***	(-0.802)	(0.564)	(-1.974)*		
SHRCH	-0.031	0.742	0.075	-0.204	-0.067	0.043	-0.016	0.546	165.550
	(-10.419)***	(30.921)***	(1.749)*	(-3.224)***	(-1.146)	(0.835)	(-0.424)		
SHRAL	-0.036	0.693	0.093	-0.117	-0.017	-0.003	0.018	0.418	99.189
	(-10.127)***	(24.247)***	(1.821)*	(-1.549)	(-0.239)	(-0.041)	(0.402)		
SHRAH	-0.032	0.740	-0.011	-0.143	-0.060	-0.023	0.021	0.621	225.143
	(-12.689)***	(36.460)***	(-0.309)	(-2.667)***	(-1.215)	(-0.531)	(0.691)		
BLWCL	-0.033	0.728	-0.038	-0.459	-0.283	0.151	0.074	0.731	372.480
	(-14.637)***	(40.557)***	(-1.189)	(-9.694)***	(-6.489)***	(3.916)***	(2.682)**		
BLWCH	-0.033	0.728	-0.038	-0.459	-0.283	0.151	-0.926	0.779	484.504
	(-14.637)***	(40.557)***	(-1.189)	(-9.694)***	(-6.489)***	(3.916)***	(-33.665)***		
BLWAL	-0.033	0.728	-0.038	-0.459	-0.283	-0.849	0.074	0.722	356.082
	(-14.637)***	(40.557)***	(-1.189)	(-9.694)***	(-6.489)***	(-22.008)***	(2.682)**		
BLWAH	-0.033	0.727	-0.066	-0.231	-0.140	-0.034	-0.029	0.560	175.402
	(-11.590)***	(31.630)***	(-1.603)*	(-3.814)***	(-2.512)**	(-0.692)	(-0.810)		
BLRCL	-0.033	0.728	-0.038	-0.459	0.717	0.151	0.074	0.703	325.226
	(-14.637)***	(40.557)***	(-1.189)	(-9.694)***	(16.419)***	(3.916)***	(2.682)**		
BLRCH	-0.033	0.723	-0.019	-0.170	-0.069	-0.063	0.025	0.516	146.826
	(-10.653)***	(29.390)***	(-0.445)	(-2.622)***	(-1.162)	(-1.200)	(0.651)		
BLRAL	-0.032	0.730	-0.030	-0.045	-0.111	0.031	0.071	0.554	171.066
	(-11.282)***	(31.641)***	(-0.723)	(-0.741)	(-1.973)*	(0.626)	(2.006)**		
BLRAH	-0.033	0.727	-0.014	-0.345	-0.155	-0.016	-0.081	0.564	177.917
	(-11.299)***	(31.237)***	(-0.338)	(-5.628)***	(-2.743)**	(-0.328)	(-2.261)**		
BHWCL	-0.033	0.728	-0.038	0.541	-0.283	0.151	0.074	0.685	298.218
	(-14.637)***	(40.557)***	(-1.189)	(11.430)***	(-6.489)***	(3.916)***	(2.682)**		
BHWCH	-0.022	0.806	-0.418	0.038	-0.046	0.107	0.033	0.339	71.173
	(-4.380)***	(19.637)***	(-5.723)***	(0.350)	(-0.459)	(1.218)	(0.522)		
BHWAL	-0.015	0.893	-2.244	-0.053	-0.194	0.120	0.204	0.240	44.223
	(-1.280)	(9.194)***	(-12.991)***	(-0.208)	(-0.824)	(0.574)	(1.369)		
BHWAH	-0.034	0.720	0.011	-0.118	0.012	0.043	0.021	0.545	164.624
	(-11.757)***	(31.226)***	(0.279)	(-1.948)*	(0.210)	(0.868)	(0.584)		
BHRCL	-0.039	0.684	-5.176	-0.721	0.483	-0.111	0.201	0.419	99.519
	(-2.475)**	(5.465)***	(-23.278)***	(-2.188)***	(1.590)	(-0.414)	(1.048)		
BHRCH	-0.032	0.733	-0.017	-0.190	-0.041	-0.004	0.029	0.530	155.450
	(-10.424)***	(30.136)***	(-0.404)	(-2.959)***	(-0.698)	(-0.075)	(0.779)		
BHRAL	0.054	1.295	-6.907	0.911	-1.242	0.157	-0.011	0.422	100.767
	(2.545)***	(7.667)***	(-23.006)***	(2.046)**	(-3.026)***	(0.433)	(-0.043)		
BHRAH	-0.093	0.088	-1.083	-0.644	-0.051	-0.410	0.299	0.016	3.209
	(-4.450)***	(0.521)	(-3.611)***	(-1.449)	(-0.124)	(-1.130)	(1.156)		

Note: The value in parentheses shows the t-statistic, and */**/*** shows the level of significance at 10, 5, and 1% level, respectively. Moreover, during an economic crisis, we used data from September 2014 to December 2017.

Table A3. Model Performance Post-Economic Crisis

	Intercept	MKT	SMB	HML	RMW	CMA	LBR	Adj-R^2	F-stat
SLWCL	-0.035	0.437	0.102	0.017	-0.012	0.292	-0.089	0.139	15.721
	(-10.856)***	(8.398)***	(1.665)**	(0.942)	(-0.163)	(4.544)***	(-1.332)		
SLWCH	-0.039	-0.768	3.027	0.324	-0.361	0.362	-0.464	0.323	44.273
	(-3.375)***	(-4.123)***	(13.752)***	(5.059)***	(-1.378)	(1.576)	(-1.951)*		
SLWAL	-0.038	0.381	0.074	0.017	0.044	0.154	0.024	0.087	9.700
	(-11.536)***	(7.165)***	(1.186)	(0.926)	(0.595)	(2.350)***	(0.351)		
SLWAH	-0.039	0.384	0.061	0.009	-0.006	0.171	-0.007	0.091	10.068
	(-11.567) **	(7.165)***	(0.970)	(0.506)	(-0.075)	(2.588)**	(-0.099)		
SLRCL	-0.036	0.405	0.024	-0.007	0.057	0.190	0.020	0.100	11.136
	(-10.738)***	(7.420)***	(0.365)	(-0.380)	(0.742)	(2.820)***	(0.284)		
SLRCH	-0.034	0.450	0.020	0.001	0.088	0.182	-0.058	0.142	16.030
	(-11.238)***	(9.249)***	(0.348)	(0.050)	(1.287)	(3.026)***	(-0.936)		
SLRAL	-0.038	0.382	0.089	0.026	0.178	0.082	0.219	0.074	8.233
	(-9.845)***	(6.126)***	(1.212)	(1.197)	(2.031)**	(1.066)	(2.754)***		
SLRAH	-0.035	0.434	0.105	-0.004	0.157	0.244	0.051	0.104	11.576
	(-9.629)***	(7.389)***	(1.512)	(-0.191)	(1.899)*	(3.371)***	(0.674)		
SHWCL	0.020	0.864	-2.146	-0.174	-0.394	-0.340	-0.282	0.058	6.632
	(0.869)	(2.359)**	(-4.954)***	(-1.377)	(-0.765)	(-0.751)	(-0.602)		
SHWCH	-0.102	-1.447	-0.552	1.369	0.697	1.500	-0.853	0.141	15.949
	(-3.413)***	(-3.001)***	(-0.968)	(8.256)***	(1.028)	(2.520)**	(-1.386)		
SHWAL	-0.039	0.369	0.064	0.002	0.039	0.167	-0.017	0.095	10.566
	(-12.709)***	(7.429)***	(1.090)	(0.126)	(0.557)	(2.724)***	(-0.265)		
SHWAH	-0.035	0.410	0.066	-0.002	0.120	0.151	-0.065	0.103	11.434
	(-10.810)***	(7.869)***	(1.072)	(-0.084)	(1.634)*	(2.348)**	(-0.982)		
SHRCL	-0.039	0.404	0.108	0.003	0.153	0.338	-0.016	0.134	15.069
	(-11.960)***	(7.802)***	(1.769)*	(0.164)	(2.106)**	(5.286)***	(-0.248)		
SHRCH	-0.037	0.410	-0.002	-0.011	0.009	0.248	-0.068	0.127	14.180
	(-11.512)***	(8.010)***	(-0.027)	(-0.619)	(0.129)	(3.924)***	(-1.034)		
SHRAL	-0.038	0.399	0.065	0.020	-0.147	0.018	-0.070	0.154	17.481
	(-14.922)***	(9.798)***	(1.343)	(1.433)	(-2.573)**	(0.363)	(-1.352)		
SHRAH	-0.038	0.388	0.066	0.005	-0.058	0.293	-0.202	0.128	14.349
	(-11.930)***	(7.604)***	(1.099)	(0.269)	(-0.803)	(4.649)***	(-3.107)***		
BLWCL	-0.037	0.387	-0.059	-0.017	-0.303	0.363	0.235	0.449	74.921
	(-16.320)***	(10.515)***	(-1.357)	(-1.358)	(-5.853)***	(7.981)***	(4.996)***		
BLWCH	-0.037	0.387	-0.059	-0.017	-0.303	0.363	-0.765	0.424	67.881
	(-16.320)***	(10.515)***	(-1.357)	(-1.358)	(-5.853)***	(7.981)***	(-16.294)***		
BLWAL	-0.037	0.387	-0.059	-0.017	-0.303	-0.637	0.235	0.383	57.343
	(-16.320)***	(10.515)***	(-1.357)	(-1.358)	(-5.853)***	(-14.033)***	(4.996)***		
BLWAH	-0.035	0.426	-0.061	0.003	0.126	0.087	0.153	0.180	20.983
	(-13.448)***	(10.024)***	(-1.223)	(0.228)	(2.105)**	(1.666)*	(2.823)***		
BLRCL	-0.037	0.387	-0.059	-0.017	0.697	0.363	0.235	0.366	53.545
	(-16.320)***	(10.515)***	(-1.357)	(-1.358)	(13.489)***	(7.981)***	(4.996)***		
BLRCH	-0.038	0.373	-0.098	-0.017	-0.016	0.003	0.129	0.126	14.126
	(-13.089)***	(7.887)***	(-1.752)*	(-1.073)	(-0.243)	(0.054)	(2.140)***		
BLRAL	-0.036	0.412	-0.017	-0.006	0.059	0.160	0.044	0.110	12.193

	Intercept	MKT	SMB	HML	RMW	CMA	LBR	Adj-R^2	F-stat
	(-10.929)***	(7.798)***	(-0.276)	(-0.326)	(0.788)	(2.454)**	(0.656)		
BLRAH	-0.037	0.391	-0.101	-0.019	0.131	0.179	0.089	0.093	10.311
	(-10.158)***	(6.586)***	(-1.447)	(-0.916)	(1.575)	(2.443)**	(1.170)		
BHWCL	-0.037	0.387	-0.059	0.983	-0.303	0.363	0.235	0.920	1041.511
	(-16.320)***	(10.515)	(-1.357)	(77.697)***	(-5.853)***	(7.981)***	(4.996)***		
BHWCH	-0.086	-1.076	-1.606	1.405	0.568	1.695	-1.104	0.175	20.329
	(-3.066)***	(-2.393)***	(-3.022)***	(9.087)***	(0.899)	(3.053)***	(-1.923)*		
BHWAL	-0.040	0.351	-0.013	-0.001	-0.181	0.192	-0.320	0.119	13.221
	(-12.495)***	(6.808)***	(-0.209)	(-0.077)	(-2.502)**	(3.013) ***	(-4.855)***		
BHWAH	-0.038	0.377	-0.047	0.009	0.091	0.136	0.082	0.121	13.562
	(-13.120)***	(8.107)***	(-0.857)	(0.590)	(1.388)	(2.366)**	(1.374)		
BHRCL	-0.039	0.361	-0.108	0.005	-0.060	0.169	-0.082	0.137	15.398
	(-14.127)***	(8.112)***	(-2.051)**	(0.353)	(-0.954)	(3.079)***	(-1.447)		
BHRCH	-0.037	0.392	-0.041	0.003	-0.053	0.192	-0.224	0.136	15.278
	(-12.497)***	(8.233)***	(-0.731)	(0.208)	(-0.788)	(3.259)***	(-3.674)***		
BHRAL	0.008	-0.441	-12.372	-0.693	0.350	0.170	-0.764	0.514	97.201
	(0.283)	(-0.995)	(-23.610)***	(-4.548)***	(0.561)	(0.310)	(-1.349)		
BHRAH	-0.036	0.404	-0.067	-0.008	0.063	0.260	-0.056	0.126	14.110
	(-11.296)***	(7.814)***	(-1.102)	(-0.477)	(0.873)	(4.066)***	(-0.843)		

Note: The value in parentheses shows the t-statistic, and */**/*** shows the significance level at 10, 5, and 1%, respectively. Moreover, for post-crisis analysis, we used data from January 2018 to March 2020.

Table A4. Model Performance During the COVID-19 Pandemic

	Intercept	MKT	SMB	HML	RMW	CMA	LBR	Adj-R^2	F-stat
SLWCL	-0.011	0.821	0.183	-0.024	-0.278	-0.238	-0.061	0.694	213.263
	(-5.384)***	(35.089)***	(2.282)***	(-1.023)	(-2.250)***	(-3.369)***	(-0.573)		
SLWCH	-0.008	0.856	0.138	-0.025	-0.150	-0.036	-0.124	0.733	258.337
	(-4.356)***	(39.072)***	(1.835)**	(-1.121)	(-1.296)	(-0.540)	(-1.246)		
SLWAL	-0.009	0.841	0.263	-0.015	-0.274	-0.350	0.187	0.656	179.765
	(-3.771)***	(31.837)***	(2.912)***	(-0.572)	(-1.967)*	(-4.401)***	(1.567)		
SLWAH	-0.010	0.821	0.241	-0.022	-0.252	-0.281	-0.083	0.691	210.414
	(-5.058)***	(34.755)***	(2.978)***	(-0.928)	(-2.022)**	(-3.950)***	(-0.780)		
SLRCL	-0.012	0.811	0.127	-0.023	-0.148	-0.276	-0.016	0.732	256.891
	(-6.429)***	(38.553)***	(1.762)*	(-1.074)	(-1.332)	(-4.352)***	(-0.163)		
SLRCH	-0.011	0.830	0.154	-0.017	-0.185	-0.164	-0.190	0.714	234.588
	(-5.717)***	(37.054)***	(2.009)**	(-0.762)	(-1.565)	(-2.425)***	(-1.881)*		
SLRAL	-0.008	0.858	0.200	-0.025	0.060	-0.082	0.155	0.709	228.712
	(-3.775)***	(36.678)***	(2.495)**	(-1.041)	(0.488)	(-1.163)	(1.469)		
SLRAH	-0.010	0.830	0.212	-0.018	0.023	-0.276	0.255	0.689	208.981
	(-4.913)***	(34.668)***	(2.583)***	(-0.720)	(0.181)	(-3.821)***	(2.360)**		
SHWCL	0.062	1.381	-2.355	-0.034	-1.225	-0.599	-0.748	0.093	10.553
	(3.636)***	(6.902)***	(-3.440)***	(-0.169)	(-1.160)	(-0.993)	(-0.826)		
SHWCH	-0.011	0.100	8.795	1.492	0.038	-0.273	1.372	0.566	122.907
	(-1.217)	(0.938)	(24.071)***	(13.755)***	(0.067)	(-0.849)	(2.841)***		
SHWAL	-0.008	0.852	0.159	-0.025	-0.052	-0.059	-0.071	0.742	270.064
	(-4.659)***	(39.971)***	(2.188)**	(-1.164)	(-0.459)	(-0.914)	(-0.738)		
SHWAH	-0.010	0.831	0.135	-0.020	-0.207	-0.015	-0.101	0.722	244.652
	(-5.290) **	(37.972)***	(1.796)*	(-0.901)	(-1.790)	(-0.231)	(-1.025)		
SHRCL	-0.010	0.831	0.154	-0.033	-0.130	-0.012	0.075	0.726	248.649

	Intercept	MKT	SMB	HML	RMW	CMA	LBR	Adj-R²	F-stat
	(-5.565)***	(38.206)***	(2.077)**	(-1.475)	(-1.134)	(-0.181)	(0.759)		
SHRCH	-0.009	0.842	0.259	-0.008	-0.203	-0.235	0.004	0.698	217.431
	(-4.513)***	(35.433)***	(3.190)***	(-0.323)	(-1.617)*	(-3.284)***	(0.033)		
SHRAL	-0.012	0.817	0.081	-0.019	-0.180	0.027	-0.267	0.747	277.298
	(-7.097)***	(40.532)***	(1.171)	(-0.906)	(-1.697)*	(0.448)	(-2.928)***		
SHRAH	-0.011	0.840	0.081	-0.018	-0.418	0.005	-0.357	0.766	306.816
	(-6.193)***	(42.355)***	(1.188)	(-0.878)	(-3.991)***	(0.080)	(-3.978)***		
BLWCL	-0.011	0.823	0.057	-0.037	-0.443	0.050	0.327	0.782	336.680
	(-6.571)***	(43.340)***	(0.883)	(-1.922)*	(-4.416)***	(0.870)	(3.810)***		
BLWCH	-0.011	0.823	0.057	-0.037	-0.443	0.050	-0.673	0.776	324.973
	(-6.571)***	(43.340)***	(0.883)	(-1.922)*	(-4.416)***	(0.870)	(-7.832)***		
BLWAL	-0.011	0.823	0.057	-0.037	-0.443	-0.950	0.327	0.802	380.763
	(-6.571)***	(43.340)***	(0.883)	(-1.922)*	(-4.416)***	(-16.595)***	(3.810)***		
BLWAH	-0.010	0.832	0.061	-0.029	0.129	-0.075	0.262	0.760	298.136
	(-6.139)***	(41.875)***	(0.893)	(-1.449)	(1.229)	(-1.254)	(2.920)***		
BLRCL	-0.011	0.823	0.057	-0.037	0.557	0.050	0.327	0.772	317.966
	(-6.571)***	(43.340)***	(0.883)	(-1.922)*	(5.557)***	(0.870)	(3.810)***		
BLRCH	-0.011	0.813	0.041	-0.024	-0.120	-0.290	0.283	0.676	196.461
	(-5.441)***	(33.503)***	(0.488)	(-0.980)	(-0.934)	(-3.959)***	(2.580)***		
BLRAL	-0.011	0.821	0.033	-0.022	-0.040	-0.214	0.048	0.743	271.462
	(-6.428)***	(39.845)***	(0.473)	(-1.054)	(-0.364)	(-3.455)***	(0.514)		
BLRAH	-0.009	0.829	0.072	-0.027	0.080	-0.055	0.271	0.724	246.398
	(-5.037)***	(38.038)	(0.971)	(-1.239)	(0.697)	(-0.835)	(2.752)***		
BHWCL	-0.011	0.823	0.057	0.963	-0.443	0.050	0.327	0.888	746.048
	(-6.571)***	(43.340)***	(0.883)	(49.917)***	(-4.416)***	(0.870)	(3.810)***		
BHWCH	-0.008	0.873	-0.387	-0.012	-0.458	-0.087	-0.342	0.592	136.945
	-(2.932)***	(28.040)***	(-3.629)***	(-0.373)	(-2.789)***	(-0.932)	(-2.432)***		
BHWAL	-0.011	0.819	0.064	-0.024	-0.489	0.089	-0.607	0.749	280.351
	(-6.272)***	(40.276)***	(0.926)	(-1.157)	(-4.559)***	(1.452)	(-6.608)***		
BHWAH	-0.012	0.820	0.059	0.005	0.027	-0.151	0.122	0.744	273.705
	(-7.054)***	(40.115)***	(0.845)	(0.221)	(0.249)	(-2.452)**	(1.316)		
BHRCL	-0.010	0.835	-0.007	0.004	-0.188	-0.085	-0.160	0.743	272.316
	(-5.674)***	(40.089)***	(-0.092)	(0.166)	(-1.705)	(-1.348)	(-1.703)*		
BHRCH	-0.012	0.819	-0.002	-0.002	-0.360	-0.102	-0.244	0.693	211.959
	(-6.055)***	(35.205)***	(-0.023)	(-0.104)	(-2.932)***	(-1.453)	(-2.317)**		
BHRAL	0.091	1.151	-5.739	-0.074	-0.324	-0.468	-0.689	0.119	13.648
	(4.687)***	(5.046)***	(-7.355)***	(-0.318)	(-0.269)	(-0.680)	(-0.668)		
BHRAH	-0.030	0.433	-1.658	0.558	-0.624	-0.675	0.451	0.194	23.605
	(-4.488)***	(5.587)***	(-6.259)***	(7.097)***	(-1.528)	(-2.890)***	(1.288)		

Note: The value in parentheses shows the t-statistics, and */**/*** shows the significance level at 10, 5, and 1%, respectively. Moreover, during the COVID-19 pandemic, we used data from March 2020 to June 2022.

Table A5. Model Performance Post-COVID-19 Pandemic

	Intercept	MKT	SMB	HML	RMW	CMA	LBR	Adj-R²	F-stat
SLWCL	-0.106	0.196	-0.009	0.000	-0.027	-0.008	0.003	0.158	8.967
	(-29.067)***	(7.175) ***	(-0.573)	(-0.127)	(-0.789)	(-0.261)	(0.151)		
SLWCH	-0.101	0.235	-0.016	0.001	0.100	-0.046	0.071	0.049	3.179
	(-11.536)***	(3.604) ***	(-0.455)	(0.432)	(1.225)	(-0.654)	(1.521)		
SLWAL	-0.087	0.338	-0.051	0.000	0.245	-0.107	0.098	0.107	6.107

	Intercept	MKT	SMB	HML	RMW	CMA	LBR	Adj-R²	F-stat
	(-7.502)***	(3.882) ***	(-1.070)	(-0.035)	(2.241)***	(-1.133)	(1.591)		
SLWAH	-0.084	0.355	-0.032	-0.001	0.168	-0.269	0.175	0.219	12.904
	(-9.116)***	(5.135) ***	(-0.848)	(-0.368)	(1.930)*	(-3.596)***	(3.561)***		
SLRCL	-0.107	0.197	-0.008	0.000	-0.024	-0.012	0.006	0.178	10.180
	(-31.139)***	(7.666) ***	(-0.593)	(-0.079)	(-0.759)	(-0.418)	(0.338)		
SLRCH	-0.060	0.529	0.454	0.001	0.269	0.047	0.176	0.119	6.760
	(-2.717)***	(3.221)***	(5.042)***	(0.198)	(1.305)	(0.267)	(1.504)		
SLRAL	-0.104	0.220	-0.036	0.003	0.274	-0.086	0.140	0.083	4.870
	(-9.283)***	(2.623)***	(-0.774)	(0.878)	(2.608)***	(-0.953)	(2.346)***		
SLRAH	-0.010	0.870	1.051	-0.001	0.754	0.140	0.391	0.113	6.441
	(-0.196)	(2.337)**	(5.155)***	(-0.047)	(1.613)*	(0.349)	(1.479)		
SHWCL	-0.097	0.267	-0.015	-0.001	0.043	-0.001	0.020	0.131	7.386
	(-17.524)***	(6.460)***	(-0.676)	(-0.276)	(0.819)	(-0.026)	(0.684)		
SHWCH	-0.116	0.063	0.331	0.873	-0.044	0.596	0.173	0.923	508.092
	(-2.481)***	(0.179)	(1.728)*	(55.061)***	(-0.101)	(1.577)	(0.696)		
SHWAL	-0.096	0.247	0.008	0.001	-0.008	0.036	-0.018	0.140	7.893
	(-19.157)***	(6.582)***	(0.401)	(0.301)	(-0.173)	(0.885)	(-0.686)		
SHWAH	-0.050	0.610	0.376	0.003	0.318	0.019	0.191	0.092	5.296
	(-2.123)**	(3.431)***	(3.866)***	(0.342)	(1.423)	(0.100)	(1.511)		
SHRCL	-0.104	0.211	-0.008	0.000	-0.007	0.020	-0.002	0.151	8.543
	(-25.927)***	(7.007)***	(-0.478)	(0.226)	(-0.194)	(0.614)	(-0.103)		
SHRCH	-0.105	0.204	-0.005	0.000	-0.008	0.007	0.006	0.165	9.423
	(-28.606)***	(7.429)***	(-0.312)	(0.320)	(-0.244)	(0.233)	(0.320)		
SHRAL	-0.111	0.161	-0.027	0.000	0.151	0.063	0.061	0.021	1.899
	(-13.966)***	(2.705)**	(-0.817)	(0.080)	(2.018)**	(0.988)	(1.455)		
SHRAH	-0.102	0.231	-0.010	0.000	-0.013	0.012	0.002	0.175	10.008
	(-25.115)***	(7.616)***	(-0.624)	(-0.013)	(-0.350)	(0.368)	(0.072)		
BLWCL	-0.103	0.223	-0.065	0.000	-0.259	0.248	0.137	0.461	37.368
	(-13.841)***	(4.019)***	(-2.122)**	(0.188)	(-3.707)***	(4.134)***	(3.483)***		
BLWCH	-0.103	0.223	-0.065	0.000	-0.259	0.248	-0.863	0.687	94.242
	(-13.841)***	(4.019)***	(-2.122)**	(0.188)	(-3.707)***	(4.134)***	(-21.851)***		
BLWAL	-0.103	0.223	-0.065	0.000	-0.259	-0.752	0.137	0.479	40.129
	(-13.841) ***	(4.019)***	(-2.122)**	(0.188)	(-3.707)***	(-12.534)***	(3.483)***		
BLWAH	-0.100	0.240	0.004	-0.001	-0.027	-0.114	0.071	0.091	5.278
	(-15.282)***	(4.909)***	(0.159)	(-0.328)	(-0.443)	(-2.152)***	(2.032)**		
BLRCL	-0.103	0.223	-0.065	0.000	0.741	0.248	0.137	0.369	25.833
	(-13.841)***	(4.019)***	(-2.122)**	(0.188)	(10.622)***	(4.134)***	(3.483)***		
BLRCH	-0.106	0.199	-0.004	0.000	-0.028	-0.018	0.010	0.181	10.415
	(-30.798)***	(7.760)***	(-0.292)	(0.068)	(-0.856)	(-0.648)	(0.541)		
BLRAL	-0.029	0.733	-7.190	-0.060	1.117	0.223	0.640	0.864	271.842
	(-0.653)	(2.224)**	(-39.854)***	(-4.031)***	(2.699)**	(0.627)	(2.734)***		
BLRAH	-0.092	0.303	-0.082	0.001	0.096	-0.253	0.136	0.158	8.971
	(-9.464)***	(4.148)***	(-2.056)**	(0.338)	(1.051)	(-3.213)***	(2.617)***		
BHWCL	-0.103	0.223	-0.065	1.000	-0.259	0.248	0.137	0.998	26630.395
	(-13.841)***	(4.019)***	(-2.122)**	(397.329)***	(-3.707)***	(4.134)***	(3.483)***		
BHWCH	-0.096	0.245	0.004	0.000	-0.040	-0.007	-0.005	0.151	8.550
	(-20.501)***	(6.969)***	(0.194)	(-0.033)	(-0.895)	(-0.182)	(-0.197)		
BHWAL	-0.029	0.736	-7.170	-0.060	1.118	0.392	0.570	0.863	269.576
	(-0.668)	(2.232)***	(-39.748)***	(-4.001)***	(2.703)***	(1.101)	(2.434)**		
BHWAH	-0.105	0.205	-0.007	0.000	-0.011	0.000	0.010	0.189	10.885

	Intercept	MKT	SMB	HML	RMW	CMA	LBR	Adj-R^2	F-stat
	(-30.679)***	(8.002)***	(-0.518)	(0.077)	(-0.339)	(0.017)	(0.562)		
BHRCL	-0.065	0.486	0.695	-0.001	0.097	-0.038	0.157	0.251	15.256
	(-3.343)***	(3.329)***	(8.698)***	(-0.184)	(0.532)	(-0.243)	(1.513)		
BHRCH	-0.107	0.196	-0.006	0.001	0.013	0.035	0.009	0.181	10.410
	(-31.526)***	(7.749)***	(-0.444)	(0.685)	(0.408)	(1.297)	(0.486)		
BHRAL	-0.110	0.135	0.215	-0.003	0.034	0.090	0.064	0.020	1.847
	(-5.895) ***	(0.968)	(2.821)***	(-0.474)	(0.197)	(0.601)	(0.643)		
BHRAH	-0.087	0.339	-0.132	0.001	0.112	-0.137	0.145	0.017	1.729
	(-4.158)***	(2.178)**	(-1.545)	(0.179)	(0.573)	(-0.816)	(1.310)		

Note: The value in parentheses shows the t statistics, and */**/*** shows the level of significance at 10, 5, and 1% level respectively. Moreover, for the post-COVID-19 pandemic, we use the data spanning from July 2022 to June 2023.

Table A6. Model Comparison Based on Adjusted-R Squared (Adj-R^2**)**

P	Full Sample	Pre-Crisis	During Crisis	Post-Crisis	COVID-19	Post COVID-19
SLWCL	71.30%	51.13%	54.21%	13.95%	69.38%	15.79%
SLWCH	42.21%	53.46%	55.61%	32.27%	73.31%	4.88%
SLWAL	67.46%	44.28%	51.77%	8.74%	65.62%	10.73%
SLWAH	67.37%	39.26%	48.13%	9.08%	69.10%	21.88%
SLRCL	69.50%	33.49%	56.99%	10.04%	73.20%	17.76%
SLRCH	65.04%	43.74%	46.11%	14.20%	71.38%	11.93%
SLRAL	69.33%	48.20%	54.20%	7.38%	70.85%	8.35%
SLRAH	48.19%	42.46%	44.09%	10.43%	68.95%	11.35%
SHWCL	14.92%	11.21%	51.59%	5.84%	9.25%	13.06%
SHWCH	27.39%	24.73%	2.53%	14.13%	56.55%	92.27%
SHWAL	67.72%	29.46%	52.40%	9.53%	74.18%	13.96%
SHWAH	96.50%	99.62%	48.54%	10.30%	72.23%	9.18%
SHRCL	72.24%	46.79%	56.73%	13.41%	72.56%	15.07%
SHRCH	69.79%	40.63%	54.60%	12.67%	69.79%	16.54%
SHRAL	64.38%	27.24%	41.78%	15.36%	74.68%	2.07%
SHRAH	73.52%	41.59%	62.09%	12.81%	76.55%	17.49%
BLWCL	34.23%	32.88%	73.08%	44.87%	78.18%	46.11%
BLWCH	79.63%	60.83%	77.94%	42.41%	77.57%	68.69%
BLWAL	79.12%	54.61%	72.18%	38.28%	80.22%	47.94%
BLWAH	74.65%	49.70%	56.04%	18.03%	76.03%	9.14%
BLRCL	78.35%	58.92%	70.32%	36.65%	77.19%	36.88%
BLRCH	70.53%	44.70%	51.59%	12.63%	67.60%	18.14%
BLRAL	22.34%	47.16%	55.41%	10.97%	74.28%	86.44%
BLRAH	69.64%	43.84%	56.39%	9.30%	72.37%	15.79%
BHWCL	97.00%	77.57%	68.48%	91.97%	88.83%	99.84%
BHWCH	16.98%	26.32%	33.90%	17.55%	59.21%	15.08%
BHWAL	15.57%	41.06%	24.01%	11.86%	74.89%	86.34%
BHWAH	68.65%	27.44%	54.46%	12.15%	74.43%	18.87%
BHRCL	12.65%	14.29%	41.86%	13.68%	74.34%	25.12%
BHRCH	30.89%	6.56%	53.02%	13.58%	69.25%	18.13%
BHRAL	9.59%	36.65%	42.17%	51.43%	11.90%	1.95%
BHRAH	7.21%	47.01%	1.59%	12.61%	19.44%	1.69%

Table A7. Ramsey RESET Test Specification: SLWAL RM-RF SMB HML RMW CMA LBR

Test Statistic	Value	Df	Probability
t-statistic	1.867942	3229	0.0619
F-statistic	3.489207	(1, 3229)	0.0619
Likelihood ratio	3.495963	1	0.0615

Table **A8.** Dependent Variable: RM_RF Method: Least Squares

Variable	Coefficient	Std. Error	t-statistic	Prob.
SMB	0.009015	0.008376	1.076294	0.2819
HML	-0.020129	0.006983	-2.882652	0.0040
RMW	-0.027011	0.056140	-0.481134	0.6305
CMA	-0.083232	0.049783	-1.671899	0.0946
LBR	0.052793	0.046017	1.181850	0.2374
RESID01	7.51E-17	0.045127	1.66E-15	1.0000
C	-0.096043	0.000667	-144.0826	0.0000

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