Journal of
Risk and Financial Management

MDPI

Article

Using the Capital Asset Pricing Model and the Fama–French Three-Factor and Five-Factor Models to Manage Stock and Bond Portfolios: Evidence from Timor-Leste

Fernando Anuno [1,2,*], Mara Madaleno [2] and Elisabete Vieira [3]

[1] Faculty of Economics and Management, National University of Timor Lorosa'e (UNTL), Díli 10000, Timor-Leste
[2] GOVCOPP—Research Unit on Governance, Competitiveness and Public Policies, Department of Economics, Management, Industrial Engineering and Tourism(DEGEIT), University of Aveiro, Campus Universitário de Santiago, 3810-193 Aveiro, Portugal; maramadaleno@ua.pt
[3] GOVCOPP Unit Research, Aveiro Institute of Accounting and Administration, University of Aveiro (ISCA-UA), Campus Universitário de Santiago, 3810-902 Aveiro, Portugal; elisabete.vieira@ua.pt
* Correspondence: fernando.anuno@ua.pt

Abstract: Timor-Leste is a new country still in the process of economic development and does not yet have a capital market for stock and bond investments. These two asset classes have been invested in international capital markets such as the US, the UK, Japan, and Europe. We examine the performance of the capital asset pricing model (CAPM) and the Fama–French three-factor and five-factor models on the excess returns of Timor-Leste's equity and bond investments in the international market over the period 2006 to 2019. Our empirical results show that the market factor (MKT) is positively and significantly associated with the excess returns of the CAPM and the Fama–French three-factor and five-factor models. Moreover, the two variables Small Minus Big (SMB) as a size factor and High Minus Low (HML) as a value factor have a negative and significant effect on the excess returns in the Fama–French three-factor model and five-factor model. Further analysis revealed that the explanatory power of the Fama–French five-factor model is that the Robust Minus Weak (RMW) factor as a profitability factor is positively and significantly associated with excess returns, while the Conservative Minus Aggressive (CMA) factor as an investment factor is insignificant.

Keywords: CAPM; Fama–French three-factor model; Fama–French five-factor model; emerging market

Citation: Anuno, Fernando, Mara Madaleno, and Elisabete Vieira. 2023. Using the Capital Asset Pricing Model and the Fama–French Three-Factor and Five-Factor Models to Manage Stock and Bond Portfolios: Evidence from Timor-Leste. *Journal of Risk and Financial Management* 16: 480. https://doi.org/10.3390/jrfm16110480

Academic Editor: Shigeyuki Hamori

Received: 22 September 2023
Revised: 4 November 2023
Accepted: 8 November 2023
Published: 12 November 2023

1. Introduction

Modern portfolio theory was initiated by Markowitz (1952) by developing important ideas about portfolios, risk, and diversification concerning different asset classes. Based on this principle, Lintner (1965), Mossin (1966), and Sharpe (1964) are considered pioneers and developers of the concept of the CAPM. The model explains the linear relationship between the systematic risk coefficient, beta, and expected stock returns (Wang et al. 2017; Anjum and Rajput 2021; Taussig 2022). Moreover, the basic concept of the CAPM is a metric that explains expected excess return, beta risk, and the market risk premium by calculating the difference between an asset's return and the risk-free rate. Therefore, beta risk is generally estimated using a linear regression model (Yamaka and Phadkantha 2021).

Over the past two decades, researchers have used the Fama–French model to estimate cross-sectional stock returns using market premium risk factors, size factors, and value factors (Fama and French 1993). Also, Fama and French (2015) proposed a five-factor model that adds two new factors to the three-factor model to capture profitability and investment. Their study was an important contribution to the development of a multifactor model for asset valuation. However, their research results remain inconsistent in explaining the abnormal excess return associated with firm size, book-to-market ratio, liquidity, price–earnings ratio, cash flow–price ratio, return on equity, volatility, and return reversal (Zhang

and Lence 2022). However, Fama and French (2017) found that average stock returns for North America, Europe, and Asia–Pacific improved with the book-to-market (B/M) ratio and profitability and were negatively related to investment. For Japan, the relationship between average returns and the B/M ratio is strong, but average returns show little relationship with profitability and investment. Furthermore, the inclusion of a momentum factor was proposed by Fama and French (2018) as an extension of a six-factor model used to assess investment risk. The researchers conducted an analysis of several metrics used to evaluate asset pricing models and identified three specific challenges associated with the six-factor model. These challenges include (1) the dilemma of choosing either cash profitability or operating profitability as variables for constructing profitability factors, (2) the decision process in choosing between long–short spread factors and excess returns, and (3) the comparison between factors based on small or large stocks and factors that include both categories. In addition, after more than two decades, in a recent paper, Fama and French (2020) used the Fama–MacBeth cross-sectional factor, originally introduced by Fama and MacBeth (1973) in the context of a time series model developed in the field of asset price research. Fama and French (2020) argue that the inclusion of cross-sectional factor returns in a time series factor model leads to better results than a time series factor return model.

Given the gaps in the CAPM model and the Fama–French model, it is, therefore, an incentive for researchers to continue to conduct extensive research, such as the study by López-García et al. (2021), which extended Fama and French (1993) and Fama and French (2015) and found that the significance level is similar to that of the capitalization factor (SMB) and that the book-to-market factor (HML) is even larger than the momentum factor (MOM). Thus, market factors with equally weighted portfolios are very significant in the model, while market factors calculated as capital-weighted portfolios (in this case, the S&P500 index) are almost irrelevant in the model. Moreover, Jareño et al. (2020) concluded that the CMA and RMW factors have a negative sign across all periods and quantiles, thus negatively affecting financial institution returns. In addition, Mosoeu and Kodongo (2020) documented the following observations: (1) There is a variable relationship between average returns and SMB, value (B/M), profitability (P), and investment (INV) by market, although the factors are not consistent across portfolio types. (2) Overall, factors in the market and factors in different markets tend to have low correlation. However, there is a high correlation between the same pairs of factors constructed using different portfolio types, suggesting that different portfolio sorting strategies provide consistent information. (3) In addition, large companies tend to have better average stock returns than small companies, and aggressive companies that buy more assets tend to have better returns than cautious companies.

In addition, Hung et al. (2019) showed that the relationship between size risk and stock returns for small companies was also significantly positive, which was in contrast to the negative relationship for large companies. Moreover, the HML factor was negatively and positively correlated with returns for large and small companies, respectively. Bank and Insam (2019) found that the contribution of risk premium is not correlated with the excess return factor and captures the isolated compensation of a particular risk factor. Likewise, the contribution of risk premium shows a negative shift after 1993. Additionally, Shaikh et al. (2019) indicated that size premium positively and significantly explains the cross-section of stock returns of small companies, while value premium positively and significantly explains the cross-section of returns of quality companies.

The CAPM, the Fama–French three-factor model, and the Fama–French five-factor model in portfolio investment studies are empirically less effective in explaining maximum return investments. Thus, our motivation for this paper is to (i) fill the gaps in the existing literature on stock and bond investing using Fama and French's (1993) three-factor model and Fama and French's (2015) five-factor model. The present article also aims to add additional knowledge to other studies that have used capital market data from four regions, (1) North America, (2) Japan, (3) Asia–Pacific, and (4) Europe, which have documented

their empirical research findings in different regions with different results, such as the study by Nichol and Dowling (2014), showing that Fama–French five-factor profitability offers the greatest potential when implemented in the market of the United Kingdom. In addition, Chai et al. (2019) found that the SMB and HML factors are insignificant, but the HML factor is excessively high for the United States. However, these factors are also important for stock prices in Australia, suggesting that the five-factor model should at least be considered as a reference model for the Australian market. Similarly, Pandey and Joshi (2021) stated in their results that the CAPM seems to be a good model for explaining the returns for Italy and Spain. The Fama–French three-factor model and the Fama–French five-factor model seem to better describe returns in Germany, while the multifactor model plays a limited role in explaining returns in France. Meanwhile, multifactor models play a role in explaining returns for the Western European market, with the sole exception of France, where they appear to be ineffective in explaining returns. In addition, Roy (2021) found that six factors produced better estimates, outperforming Fama and French's three-factor model, Carhart's four-factor model, and Fama and French's five-factor model alike. However, Fama and French (2012) stated that integrated pricing across regions did not find strong support in their tests. Nonetheless, only local models using local explanatory returns describe the average return for a portfolio by size and value versus growth. For example, further research by Fama and French (2017) found that the average returns of stocks in North America, Europe, and Asia–Pacific show a positive correlation with the book-to-market ratio (B/M) and profitability while showing a negative relationship with investment. In addition, the underperformance of small stocks, characterized by low profitability but high investment, is not taken into account. (ii) As a developing country, Timor-Leste has assets such as stocks and bonds that it can invest in the local capital market. However, when Timor-Leste did not have a local capital market, it had to invest its capital in the international markets, particularly in the form of shares of 1775 companies that invested in petroleum funds in the United States, Europe, the United Kingdom, Japan, Australia, Canada, and Norway. (iii) The total investment in equities amounted to USD 6541 million (Timor-Leste Ministry of Finance 2019), which is associated with high investment risk. Therefore, as emerging economies have not reached their true economic potential through diversification, they rely on foreign investors and the transfer of inflows to these economies (Lone et al. 2021). (iv) The capital investment of oil funds is found to be the maximum cumulative return to bring further capital into economic diversification, especially the contribution of revenues from the non-oil-and-gas sector due to the dependence on oil and gas.

Timor-Leste is a new country preparing for economic development through portfolio investment. Timor-Leste's main income comes from oil and gas. The Petroleum Fund was established in 2005 to collect Timor-Leste's petroleum revenues from the Timor Sea. As a sovereign wealth fund, the Petroleum Fund is therefore subject to legal restrictions. In addition, the petroleum funds are invested in the bond and equity markets. These portfolio investments generate profits and increase the Petroleum Fund's income in addition to domestic revenues (Doraisami 2018; John et al. 2020; Zaimovic et al. 2021).

In portfolio investment, the objective is to make a profit, but the investor (the government) is exposed to risk. This risk means that the government must understand the concept of the Fama–French model to make investment decisions efficiently. This is because investment decisions must be based on the principle of optimizing profit and minimizing risk. This risk requires the government to exercise prudence in optimizing profits through portfolio diversification. Thus, the purpose of portfolio diversification is to minimize risk by spreading assets across different asset classes (Zaimovic et al. 2021; Sahabuddin et al. 2022).

The concepts of the CAPM and the Fama–French model provide an important understanding for managers (the government) to determine the performance of small-company stocks and large-company stocks (SMB). Similarly, it is important to understand the performance of stocks with the highest value (value) and stocks with the lowest value (growth) (HML). In addition, the performance factor is shares of companies with good profits (ro-

bust) and shares of companies with weak operating profits (RMW). Similarly, the factors reflect the equity performance of companies with conservative and aggressive investment policies (CMA) (Fama and French 1993, 2015, 2017; Ali et al. 2021; Ryan et al. 2021; Taib and Benfeddoul 2023).

Thus, understanding the performance of the CAPM and the Fama–French model helps the government of Timor-Leste to identify potential investment opportunities to enhance portfolio returns. In this way, the government can make efficient investment decisions based on accurate data and information on optimal portfolio diversification. In addition, portfolio investments ensure the country's long-term financial stability, provide effective risk management, and contribute to the country's long-term development and prosperity through economic diversification (Lopes 2021; Scheiner 2021).

This paper makes two important contributions to the finance literature, particularly in portfolio investment. Our first contribution is to provide new empirical evidence to fill the gap in the finance literature that has existed since the development of the CAPM by Sharpe (1964) and Lintner (1965) and its subsequent evolution into the three-factor model of Fama and French (1993) and the five-factor model proposed later by Fama and French (2015). Second, to the best of our knowledge, this paper is the first attempt to use a new dataset from a new country still in the process of economic development, namely Timor-Leste, to examine the performance of the CAPM, Fama and French's three-factor model, and the five-factor model on the excess returns in the context of equity and bond investment in the international market. The results of Fama and French's three-factor model and five-factor model suggest that the market factor (MKT) risk has a positive effect on assets excess return considering the CAPM model, the three-factor model, and Fama and French's five-factor model. Meanwhile, the size and investment value have a significant negative effect on the excess return in the three-factor model and Fama and French's five-factor model. The probability factor has a significant positive effect on the excess return, while the investment factor has a negative but insignificant effect on excess returns. Thus, the key question of the present study is: Do the CAPM model, the Fama–French three-factor model, and the Fama–French five-factor model show significant differences in assessing the risks and potential returns of Timor-Leste equity and bond investments in international markets?

The remainder of this article is organized as follows: Section 2 presents a brief literature review; Section 3 exposes the data and methodology; Section 4 is dedicated to the empirical results; and Section 5 is the results discussion. Finally, Section 6 provides the conclusions and policy implications and suggests future research.

2. Literature Review

2.1. CAPM Model

The goal of investors in asset allocation is to maximize profits while minimizing risk. According to Saiti et al. (2020), investment consists of allocating financial resources among different classes of assets, including commodities, real estate, stocks, and bonds in domestic and international markets, benefiting from diversification strategies. These investments aim to increase wealth as the most important resource. In addition, investors have decision-making principles to minimize investment risk. One of the most important strategies of fund managers is the diversification of investments to reduce this risk. Thus, modern portfolio theory states that the portfolio option prioritizes expected returns over risk mitigation.

Several empirical studies by Sharma and Vipul (2018), Silva et al. (2020), Yunus (2020), and Dichtl et al. (2021) on the allocation of financial assets (e.g., gold, stocks, bonds, and real estate) show that funds can be fixed income, stocks or net asset values, multiple markets or currencies, and commodities. Researchers are increasingly trying to figure out what impact stocks have on other asset classes such as currencies, fixed income, and commodities. This proves that there is a value and momentum premium in currencies, government bonds, and commodities as well as equities to predict trading returns in global equities, global bonds, currencies, and commodities (Bartram et al. 2021).

In measuring the performance of funds, asset management is very important to understand the systematic risk factors and actively manage the funds. For example, a traditional stock/bond portfolio generates the same average return and contains a portfolio with a much lower risk factor. Therefore, the benefits of diversification, which significantly reduces the risk of an increase in excessive returns, are high (Bessler et al. 2021). In addition to the systematic risk factors, there are other factors, namely the Fama–French model factors, such as beta in conjunction with market factors, size, value, momentum, investment, and profitability, which are discussed in the study by Nazaire et al. (2020) to examine which factor exposures (betas) and characteristics provide independent information for US stock returns in a multifactor context and to identify betas associated with unweighted market factors, size, value, momentum, investment, and profitability. In contrast, firm characteristics associated with size, value, investment, and profitability have significant and independent explanatory power, suggesting that they are important in determining expected returns. Moreover, asset allocation is a problem for investors. Therefore, investors need to estimate expected returns when constructing an optimal portfolio. Thus, a profitable portfolio combination is a combination of stocks, bonds, and commodity classes compared to a combination of simple estimates, equally weighted portfolios, or portfolios based on historical averages (Kynigakis and Panopoulou 2022).

The work of Markowitz (1952) was seminal for modern portfolio theory. On this basis, Lintner (1965), Mossin (1966), and Sharpe (1964) developed an important financial model that establishes a simple relationship between the returns of an asset and its risk: the CAPM. The CAPM is one of the main pillars of modern finance. It empirically proves that not every investor avoids risk in portfolio investments absolutely and globally (Levy 2022).

Beta in the CAPM model is interesting to measure stock returns during stock market movements. CAPM beta is used to measure the financial performance of an investment, which can estimate the performance of management funds, cost of capital, and securities as the determinant of beta value (Liu et al. 2022). In addition, the CAPM is a financial market risk measurement model that cannot necessarily explain the relationship between risk characteristics and investment returns. Therefore, CAPM always makes a negative and inconsistent contribution to financial theory (Maneemaroj et al. 2021). Moreover, the study by Hundal et al. (2019) analyzed only secondary data for the period 2012–2016 with a sample of 90 stocks listed on the Helsinki Stock Exchange. The results suggest that the relationship between risk and return is synchronous and that the stock returns of the sample companies are less volatile than the market index.

The CAPM model is the first model for portfolio investment management, although its empirical validity shows a weak risk–return relationship. Therefore, the relationship between risk and return has long been the backbone of portfolio management (Kazmi et al. 2021). In this context, Fama and French (2015) extend the CAPM model to include investment and profitability factors to determine the factors associated with average returns in optimizing investment decisions. In addition, the error rate of the CAPM in pricing has decreased significantly compared to previous results in the empirical literature. Moreover, the beta model, which varies over time, has a similar performance to the Fama–French model in most cases. This result is consistent with increased trading activity reducing arbitrage opportunities and thus increasing market efficiency (Rojo-Suárez et al. 2022). CAPM betas positively predict portfolio and individual stock returns when market returns are expected to be high, which is about 50% of the time. Consequently, the product of beta and expected market return (CAPM) predicts out-of-sample asset returns, and the predictive power of CAPM exceeds that of alternative factor models. Strategies that exploit the joint predictive power of beta and market return prediction have average returns that increase with beta and Sharpe ratios that are up to twice those of the corresponding buy-and-hold strategies (Hasler and Martineau 2022).

Boussaidi and AlSaggaf (2022) found that the CAPM was unable to capture the offsetting gains in most Middle East and North Africa (MENA) equity markets, so the gains cannot be explained by investment risk. Moreover, the hypothesis that the representa-

tiveness heuristic causes investors to overreact does not hold for all stock markets. In contrast to the representativeness heuristic, the authors extended the five-factor model to include factors based on similar past earnings shocks and found that offsetting gains in most MENA markets are not captured by short zero-investment portfolios on portfolios with a series of shocks and positive and long gains on a portfolio with a series of negative earnings surprises.

The relationship between a security's market line (SML) and the CAPM persists if betas are appropriately adjusted before investors analyze the level of market risk among different investment securities. Therefore, the adjusted CAPM is used to show the behavior of non-average variance in explaining the CAPM anomaly, e.g., the low beta anomaly when investors with unequal variance underweight high beta (low beta) assets. Thus, the empirical analysis shows that two-thirds of investors must deviate from the mean-variance analysis to explain the low beta anomaly (Hens and Naebi 2021).

Investments always involve risks that differ from one investment market to another in the form of systematic, cross-sectional, and time-varying risks. Nonetheless, the CAPM provides an excellent risk–return framework, and market beta can reflect the risks associated with risky investments. However, there are opportunities for investors to exploit dimensional and time anomalies to improve investment returns. Since stock returns exhibit positive autocorrelation in the short-to-medium term, stocks that have performed well in the past tend to perform well in the future, while stocks that have performed poorly in the past tend to perform poorly. For this reason, Mohanty (2019) found significant differences in explaining the sources of risk, where each market is unique in terms of the characteristics of risk factors, and market risk as described by the CAPM is not a true measure of risk, which contradicts the risk–return efficiency framework. For example, lower market risk leads to higher excess returns in 19 of the 22 developed markets, which is a significant anomaly. However, the Asness, Frazzini, and Pederson (AFP) model also leads to lower market risk (15 countries) and higher alpha (11 countries) in most markets. It is also interesting to note that the CAPM is a model that leads to excess returns in developed markets. However, beyond that, each market is unique in its composition and trends, even over long periods, so a general asset allocation approach cannot be applied to all markets.

2.2. Fama–French Model

The asset pricing model is a financial theory concept that contributes to popular research in the finance literature. The concept of finance theory reveals the most commonly used asset pricing models in the financial world, such as the CAPM, arbitrage pricing theory (APT), or the Fama–Francis model. Fama and French (1992) used data on average stock returns on the New York Stock Exchange (NYSE), the American Express (AMEX), and the National Association of Securities Dealers Automated Quotations (NASDAQ) for the period 1963–1990. The empirical results of two easily quantifiable variables, market equity (ME) and the ratio of book equity to market equity (BE/ME), capture much of the average stock returns associated with size and earnings–price ratios (E/P), book capital, and leverage.

After Fama and French (1993) discovered three risk factors for portfolio investments, namely the SMB factor, the HML factor, and the low B/M, Fama and French (2015) added two more factors to the three risk factors, namely profitability and investment, to form five factors that capture the average return pattern of stocks in the investment portfolio. Moreover, the main problem of the five-factor model is that it is not able to capture the low average returns of small stocks, whose returns behave especially poorly for companies that invest in low profitability (Fama and French 2015). Hence, the results of Fama and French (2015) showed that HML is an over factor in the sense that the high average returns are fully captured by its exposure to RM-RF, SMB, and particularly RMW and CMA. Therefore, better stock returns can be expected.

Fama and French (2012) examined international stock returns in North America, Europe, Japan, and the Asia–Pacific region to detail the size, value, and momentum patterns

of average returns for developed country markets. They then examine how well they capture average returns for a portfolio of size and value or size and momentum. The results suggest that there is a premium in average returns in North America, Europe, Japan, and Asia–Pacific and that there is strong return momentum in all regions except Japan, with no sign of momentum returning in any size group. In addition, there is new evidence on how international value and momentum returns vary with company size. Except in Japan, the value premium is larger for small stocks.

Based on a sample of 500 non-financial firms from the Bombay Stock Exchange for the period 2003–2019, the data suggest the superiority of the Fama–French three-factor model over the CAPM. Sehrawat et al. (2020) demonstrated that there is evidence of market segmentation in the first half of the sample period (2003–2010). However, the second subperiod (2011–2019) showed weak signs of market integration, supported by the Johansen cointegration test, suggesting that the Indian market is gradually integrating with global markets. In addition, Lalwani and Chakraborty (2020) used multifactor asset pricing models in emerging and developed markets to compare the performance of different multifactor asset pricing models in ten emerging and developed markets. The final country selection consists of Australia, Canada, Japan, the United Kingdom, and the United States as developed markets, and China, India, Malaysia, South Korea, and Taiwan as emerging markets. They find that the FF5 model (the Fama–French five-factor model) improves the pricing of stocks in Australia, Canada, China, and the United States. Price formation in these countries appears to be more integrated. However, the superior performance in these four countries is not consistent across a wide range of test values, and the magnitude of the reduction in pricing errors relative to three- or four-factor models is often economically insignificant. For other markets, the simple three-factor model or its four-factor variants appear to be more appropriate.

Ekaputra and Sutrisno (2020) tested the Fama–French three-factor model and the Fama–French five-factor model in contrast to previous studies. They concluded that the Fama–French five-factor model does not perform better than the Fama–French three-factor model in explaining excess portfolio returns in either market. In contrast to the US market, they found that the HML factor is not redundant in either market. The results are robust for both equally weighted and value-weighted portfolios and also for different factor construction methods. For the Johannesburg Securities Exchange (JSE), Cox and Britten (2019) examined in detail the effectiveness of the FF5 model in explaining returns for the period 1991 to 2017. Their results confirmed that the three-factor models of size-value and size-profitability best describe the returns of the time series when comparing the models. The five-factor model best explains the cross-section of returns. Overall, the results show a significant inverse size premium and a negative relationship between beta and returns but also a significant value premium. The additional factors of profitability and investment help explain returns on the JSE, but profitability is more consistent than investment.

The economic environment becomes a challenge in investing assets. Therefore, investors need to evaluate the price of assets in anticipation of risk and return. Thus, investors need to evaluate the efficiency of the firm when making investment decisions. Based on this assumption, efficiency is considered an additional factor when evaluating security returns. Therefore, the study by Aygoren and Balkan (2020) investigated the role of efficiency in capital asset pricing the stocks of NASDAQ. The results show that all factors in the models are found to be valid in asset pricing. Moreover, the paper provides evidence that the explanatory power of the proposed four-factor model exceeds the explanatory power of the CAPM and the Fama–French three-factor model.

The Fama–French model makes the basic assumption that investment returns are influenced by the unique risk variables associated with an asset. This model is based on the assumption that investment returns are influenced by factors other than the market risk described by the CAPM. The market size factor and the value factor are the two most important determinants in this model. When the Fama–French model was further developed into five factors, two more factors were added, namely the investment factor

and the profitability factor. After careful examination of the above risk variables concerning investments in stocks and bonds, the empirical hypotheses were formulated as follows:

Hypothesis 1. *There is a significant influence of the market factor on investment returns.*

Hypothesis 2. *There is a significant influence of the size factor on investment returns.*

Hypothesis 3. *There is a significant influence of the value factor on investment returns.*

Hypothesis 4. *There is a significant influence of the profitability factor on investment returns.*

Hypothesis 5. *There is a significant influence of the investment factor on investment returns.*

3. Data and Methodology

3.1. Data Collection

Our study uses data on returns on investments in petroleum funds in the form of stocks and bonds collected by the Ministry of Finance of Timor-Leste. Monthly data on stock and bond returns are provided by the Petroleum Fund Policy and Management Office in the form of raw Excel data. The objective of our study is to identify the CAPM model, the three factors of the Fama–French model, and the five factors of the Fama–French model in determining the return of stocks in the international stock market. The research approach used is to test the effects of the variables of the three-factor model and the five-factor model on the excess return of the oil fund investment portfolio using monthly data for 2006–2019. The authors analyze five explanatory variables in regression equations (2) and (3), including market, SMB, HML, RMW, and CMA factors, using data from French's data library, accessible at http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html (accessed on 14 January 2022). Table 1 also provides a brief description and definition of the explanatory variables. In addition, Figure 1 shows the time evolution of excess returns on stock and bond investments with variations in the investment risk factors of the Fama–French model over the sample period.

Table 1. Variable definitions and data specification.

Measure	Definition	Data Source
Excess returns	A return earned by an investment in excess of a risk-free investment.	Ministry of Finance of Timor-Leste
MKT (market factor)	Return investment minus risk-free rate is the excess return on Timor-Leste portfolio investment.	http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html (accessed on 7 November 2023)
SMB (size)	Small Minus Big is the difference between the average returns of companies in small equity portfolios and companies in large equity portfolios.	
HML (value)	High Minus Low is the difference between the average return on the value portfolio and the growth portfolio.	
RMW (profitability)	The difference between the returns of companies with robust (high) and weak (low) operating profitability.	
CMA (investment)	The difference between the returns of companies that invest conservatively and companies that invest aggressively.	

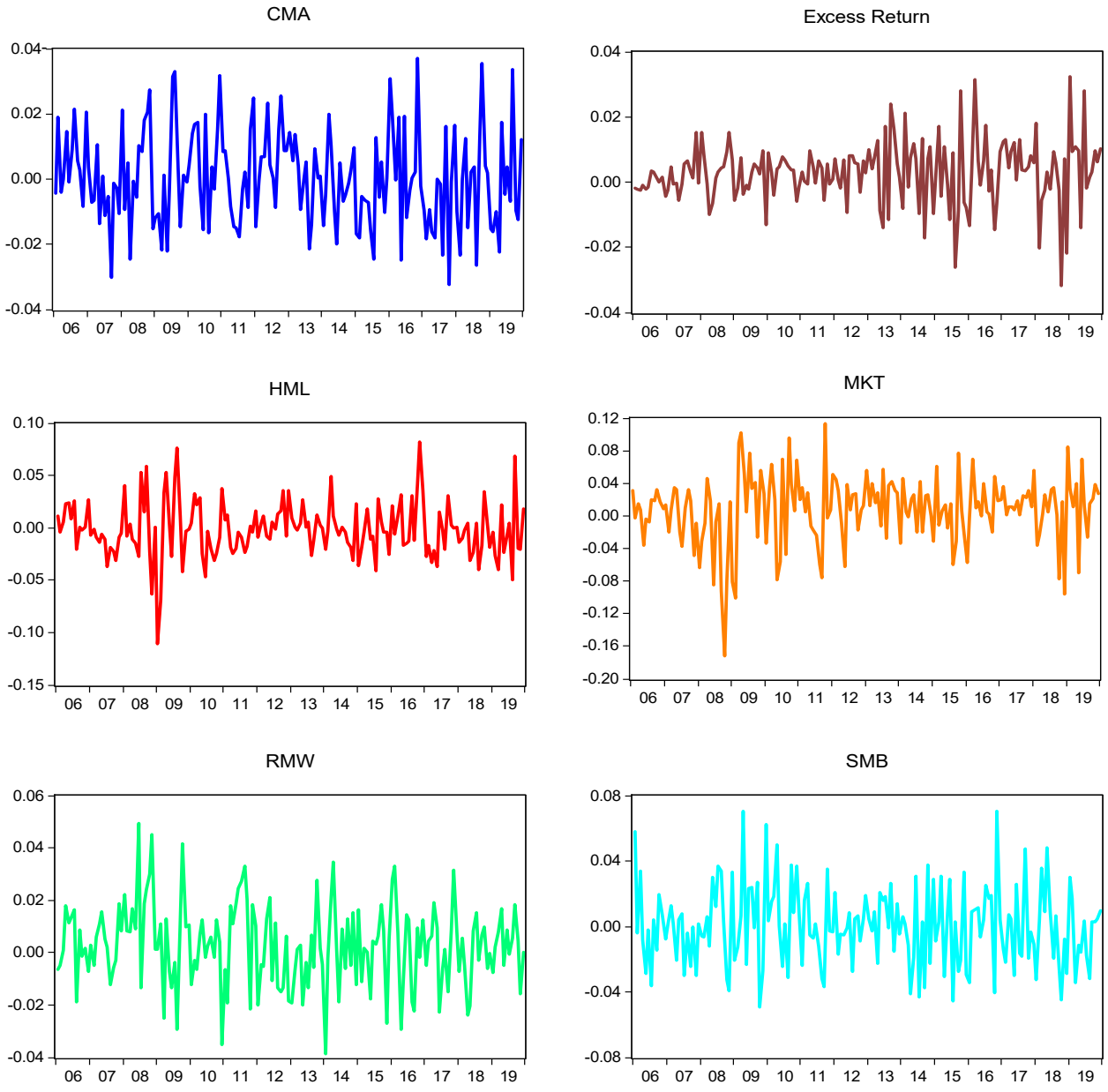

Figure 1. Time trend of excess return on equity and bonds and the Fama–French five-factor model. Source: own elaboration. This figure is the monthly value of portfolio investments since 2005, i.e., the monthly excess returns plus five investment factors such as market premium (MKT), size (SMB), value (HML), profitability (RMW), and investment (CMA) in the Fama–French model, which may be accessed via the Kenneth French Web. The vertical axis and the horizontal axis refer to the period from January 2006 to January 2019.

3.2. Empirical Approach

To determine the optimal return for stock and bond investments in Timor-Leste, this study uses the CAPM, the Fama–French three-factor model, and the Fama–French five-factor model. Below is a brief explanation of the testing procedures for using this model in asset valuation.

3.2.1. Capital Asset Pricing Model

The standard algebraic form of the CAPM is as follows:

$$E(R_i) = R_f + (R_m - R_f)b_i \quad (1)$$

Here, $E(R_i)$ is expected return on capital asset "i", R_f is a risk-free rate of return, R_m is the return on the market portfolio, and b_i is the index of systematic risk.

3.2.2. Fama–French Three-Factor Model

Fama and French (1993) defined three portfolios to capture risk: MKT (return on the market portfolio minus the risk-free rate), SMB (return on the portfolio of small stocks minus the return on the portfolio of big stocks), and HML (return on the portfolio of stocks with high book-to-market ratios minus the return on the portfolio of stocks with low book-to-market ratios). In portfolio investing, the asset pricing model is empirically tested to determine the function of the risk factor as the independent variable and the return of the assets as the dependent variable. Thus, the risk factors and asset returns are used in multiple regression to determine the portfolio investment formulation. Thus, Fama and French's (1993) three-factor model can be estimated using the following regression formula:

$$R_{it} - R_{Ft} = a_i + b_i(R_{Mt} - R_{Ft}) + s_i SMB_t + h_i HML_t + e_{it} \quad (2)$$

where $R_{it} - R_{Ft}$ is the excess return over the risk-free return of the portfolio i at t time, R_{Mt} is the return on the value-weight (VW) market portfolio, SMB_t is the return on a diversified portfolio of small stocks minus the return on a diversified portfolio of big stocks, HML_t is the difference between the returns on diversified portfolios of high and low B/M stocks, and e_{it} is a zero-mean residual.

3.2.3. Fama–French Five-Factor Model

After Fama and French (1993) introduced three risk factors, namely firm size, book-to-market value, and excess market return, Fama and French (2015) introduced a five-factor asset pricing model with two new factors: profitability and investment. The econometric model used for estimation is as follows:

$$R_{it} - R_{Ft} = a_i + b_i(R_{Mt} - R_{Ft}) + s_i SMB_t + h_i HML_t + r_i RMW_t + c_i CMA_t + e_{it} \quad (3)$$

where RMW_t is the factor related to firm profitability, i.e., the difference between the returns of portfolios of firms with robust (high) profitability and those with weak (low) profitability, and CMA_t is the factor related to investment, i.e., the difference between the returns of conservative (low) and aggressive (high) investment portfolios.

4. Empirical Results

4.1. Descriptive Statistics

Based on the collected data and the previously created indicators, we were able to perform a descriptive statistical analysis. The corresponding data processing was performed in STATA 14 and EViews 12.

Table 2 shows the summary statistics of all return factors of Timor-Leste stocks and bonds in the international stock market, monthly data from 2006 to 2019. The mean MKT for the return of Timor-Leste stocks and bonds is 0.75% per month, and the mean SMB premium and the mean HML premium are 0.03% and −0.19%, respectively. The monthly premiums for RMW and CMA have a value of 0.27% and 0.03% over the period 2006–2019. In addition, Table 2 shows that the MKT factor has the highest standard deviation (4.21%), and this factor has the highest risk. In addition, the CMA factor has the lowest standard deviation (1.45%) and is the factor with the lowest risk.

Table 2. Summary statistics for Fama–French factors of equity and bonds of Timor-Leste in the international stock market.

Factors	Obs.	Mean	Std. Dev.	Min	Max
MKT	168	0.0075	0.0421	−0.1723	0.1135
SMB	168	0.0003	0.024	−0.0492	0.0704
HML	168	−0.0019	0.0262	−0.1111	0.0821
RMW	168	0.0027	0.0154	−0.0388	0.0494
CMA	168	0.0003	0.0145	−0.0323	0.037
Excess Monthly Return	168	0.0028	0.0095	−0.0317	0.0323

Source: own elaboration. Note: The table provides summary statistics for the five Fama–French factors, i.e., monthly excess returns plus five investment factors: market risk premium or "portfolio return minus risk-free rate" (MKT), size or "Small Minus Big" (SMB), value or "High Minus Low" (HML), profitability or "Robust Minus Weak" (RMW), and investment or "Conservative Minus Aggressive" (CMA). The table includes statistics for the mean, standard deviation (Std. Dev.), maximum (max), and minimum (min).

4.2. Correlation Matrix

Table 3 presents the correlation coefficients between the variables included in the study. The portfolio return is positively and significantly related to the market risk premium (0.40) but negatively related to the CMA factor (−0.16). Moreover, the MKT factor is positively and significantly related to the SMB factor and the HML factor but negatively related to the RMW factor. In addition, there is a positive and significant relationship between the SMB factor and the HML factor but a negative relationship with the RMW factor. Finally, the HML factor is negatively related to the RMW factor but positively related to the CMA factor.

Table 3. Correlation among parameter and portfolio returns.

	Excess Monthly Return	MKT	SMB	HML	RMW	CMA
Excess Monthly Return	1					
MKT	0.401 ***	1				
SMB	−0.0218	0.400 ***	1			
HML	−0.104	0.258 ***	0.284 ***	1		
RMW	0.0155	−0.396 ***	−0.374 ***	−0.175 *	1	
CMA	−0.164 *	−0.110	0.0638	0.523 ***	0.0475	1

Source: own elaboration. Note: The table shows the correlation matrix for the five Fama–French factors, which consists of monthly excess returns plus five investment factors such as market risk premium or "portfolio return minus risk-free rate" (MKT), size or "Small Minus Big" (SMB), value or "High Minus Low" (HML), profitability or "Robust Minus Weak" (RMW), and investment or "Conservative Minus Aggressive" (CMA). * $p < 0.1$, *** $p < 0.01$ indicate significance levels 10% and 1%, respectively.

4.3. Regression Multipliers

The regression results for the CAPM, the Fama–French three-factor model, and the Fama–French five-factor model are presented in Table 4. The results presented in this study provide a better understanding of the elements associated with the MKT factor, the SMB factor, the HML factor, the RMW factor, and the CMA factor. The table shows that the coefficient values for the CAPM, the Fama–French three-factor model, and the Fama–French five-factor model show statistical significance or positive correlations at a 1% significance level. This means that a one-unit increase in the positive direction is associated with a positive return for both the equity and bond portfolios. The results are consistent with the research conducted by Ali et al. (2018).

Table 4. Regression results for the CAPM model, the Fama–French three-factor model, and the Fama–French five-factor model.

Factors	CAPM	Fama–French Three-Factor Model	Fama–French Five-Factor Model
MKT	0.0906 ***	0.116 ***	0.127 ***
	(0.0161)	(0.0170)	(0.0183)
SMB		−0.0673 **	−0.0543 *
		(0.0303)	(0.0310)
HML		−0.0784 ***	−0.0652 **
		(0.0257)	(0.0317)
RMW			0.0964 **
			(0.0474)
CMA			−0.00489
			(0.0550)
Constant (α)	0.00211 ***	0.00179 ***	0.00147 **
	(0.000685)	(0.000666)	(0.000686)
Observations	168	168	168
R-squared	0.1607	0.2302	0.2511
Adj. R-squared	0.1560	0.2161	0.2280
F-statistic	31.7882	16.3428	10.8647
Prob. (F-statistic)	0.0000	0.0000	0.0000

Source: own elaboration. Note: The table shows the regression multipliers for the CAPM model, the three-factor model, and the five-factor model of Fama and French, i.e., monthly excess returns plus five investment factors: market risk premium or "portfolio return minus risk-free rate" (MKT), size or "Small Minus Big" (SMB), value or "High Minus Low" (HML), profitability or "Robust Minus Weak" (RMW), and investment or "Conservative Minus Aggressive" (CMA). Significance at the 1%, 5%, and 10% levels is indicated by *** $p < 0.01$, ** $p < 0.05$, and * $p < 0.1$.

The beta coefficients of the three models for the market factor show a positive and statistically significant correlation at the 1% level. This result empirically supports the hypothesis that market factors have a significant impact on investment returns. This provides empirical evidence for our hypothesis H1. The correlation between the return on equity and bond investments and the level of risk can be seen as indicating a positive relationship, with a higher level of risk usually being associated with higher returns. Conversely, it is a common phenomenon that investors are willing to pay excessive prices for investment opportunities that are associated with lower risk. The market factor is therefore an important factor that can shed light on the results of a portfolio. According to the Fama–French three-factor model, the size factor beta has a statistically significant negative value at a 5% significance level. The results of this study provide empirical support for the hypothesis that factor size has a discernible influence on investment returns. The above results provide empirical support for hypothesis H2. In addition, the Fama–French five-factor model also shows a statistically significant negative value for the size factor beta, but at a slightly higher significance level of 10%. This result shows that the size factor exerts a statistically significant negative influence on the average return of the portfolio. The inverse correlation between the size effect and the average stock return is also evident. The results presented in this study are consistent with previous research by Banz (1981) and Fama and French (1992), which showed that smaller stocks have higher risk-adjusted returns compared to larger companies. The results of this study suggest that there is a higher risk associated with the stock returns of smaller portfolios, so investors must earn a correspondingly higher compensating return compared to larger companies.

The value factor has a statistically significant negative coefficient at the 1% level in the three-factor Fama–French model and the 5% level in the five-factor Fama–French model. The results of this research study provide empirical support for the hypothesis that the value factor exerts a discernible influence on investment returns. The above results provide empirical support for hypothesis H3. This suggests that stocks with value characteristics, sometimes referred to as value stocks, are likely to experience a decline in expected returns. This refers to the distinction between stocks with a low price-to-book ratio, which stands for

value, and stocks with a high price-to-book ratio. Furthermore, the study shows a negative correlation, suggesting that companies with a high price-to-book ratio tend to have lower average returns. This result contradicts the conclusions of Fama and French (1992), who found a positive and statistically significant correlation between average returns and the book value of equity. The strength of this correlation exceeds that of size, debt, earnings, and price as determinants of average stock returns.

The profitability factor has a statistically significant positive coefficient at the 5% level in the Fama–French five-factor model. The results of this study provide empirical evidence for the hypothesis that the profitability factor has a significant impact on investment returns. The above results provide empirical support for our hypothesis H4. This result is supported by Ali et al. (2021), and Horváth and Wang (2021), who found that the profitability factor significantly increases the description of the average return, which is in contrast to the results of Alqadhib et al. (2022), which in turn conclude that the profitability factor has a significant negative relationship with fund returns. The investment factor, on the other hand, has an insignificant effect on the excess return. This is strong evidence for the acceptance of the fifth null hypothesis (H5) and the rejection of the fifth alternative hypothesis (H5). This result is in good agreement with existing studies by Horváth and Wang (2021). However, our study does not support the recent study by Kaya (2021) that the CMA coefficient is negative and significant in eight of the twelve portfolios, and the mean return shows a strong investment pattern in the regression estimation.

The CAPM, the three-factor model, and the five-factor model of Fama and French are widely accepted models for determining the average return of a portfolio. Table 4 shows the results of the CAPM, Fama and French's three-factor model, and Fama and French's five-factor model in terms of the R^2 value of the investment portfolio, which is 21.40% on average. This means that the valuation of the change is explained by the market premium associated with the risk-free interest rate. Furthermore, it should be noted that the adjusted R^2 value of the Fama–French five-factor model, namely 0.2280, exceeds the adjusted R^2 values of both the Fama–French three-factor model (0.2161) and the CAPM model (0.1560). The observed F-statistic is statistically significant at the 1% level.

Figure 2 shows a graphical overview of the evolution of the factors over time. The market risk premium exhibits higher cumulative fluctuations compared to other portfolio investment risk factors. However, the trend of the market risk premium factor first developed positively until the end of 2008 and then negatively until mid-2011. Thereafter, the positive trend continued until the end of 2011, when it turned negative again. After mid-2011, it slowly increased in a positive direction until it reached its highest level in 2019. Thus, the market risk premium factor is always highest when it succeeds in predicting the return on investment when it is profitable. The valuation factor underperformed from 2007 until mid-2010. It then returned to a positive trend until the end of 2019, when it fell back into negative territory. This shows that small companies perform better than larger companies in the long run. The value factor only performed well from 2006 to 2007. After that, it developed negatively until 2019. This means that there is a difference in the value premium between the return of a high book-to-market portfolio and a low book-to-market portfolio, so it continues to generate negative returns (Ryan et al. 2021). The RMW factor had the best performance from the beginning of 2006 to 2019. This means that a positive value of the RMW factor indicates that the company has higher profitability and continues to exceed over the investment period of the portfolio. In addition, the CMA factor shows a decrease in investment at the end of 2008, then an increase and then a decrease in 2009, and only during the 2008/2009 financial crisis (Dirkx and Peter 2020). Finally, the over-return factor declined negatively only from 2006 to 2007, and then the contribution of the over-return rate increased significantly until 2019.

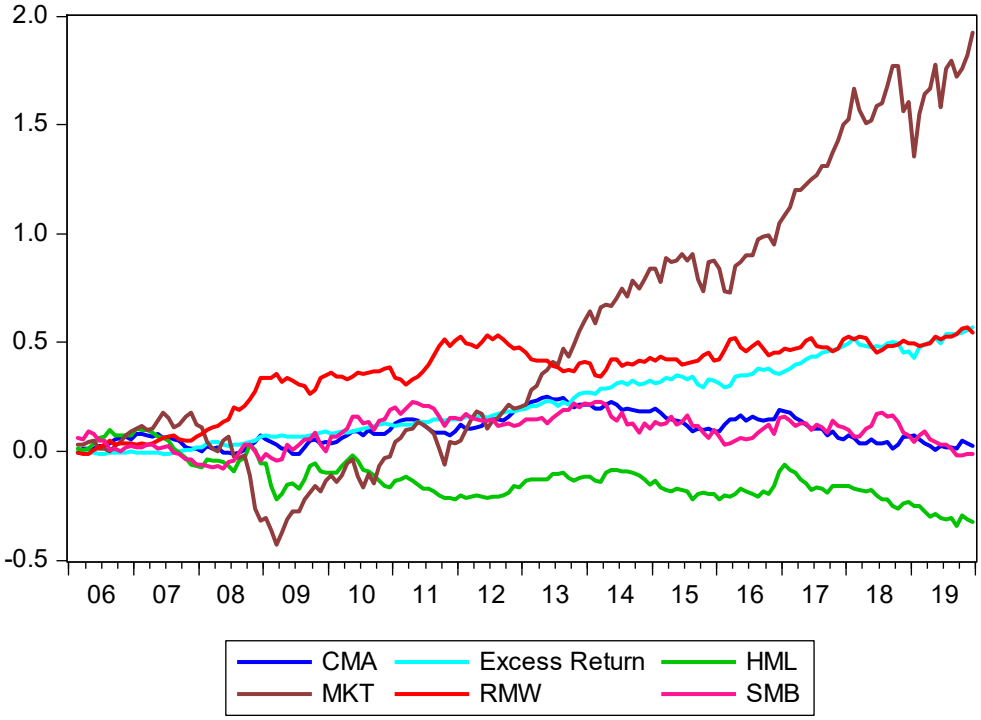

Figure 2. Cumulative value of the five factors and excess return. Source: own elaboration. This figure represents the monthly cumulative value of portfolio investments since 2005, which consists of monthly excess returns plus five investment factors such as market premium (MKT), size (SMB), value (HML), profitability (RMW), and investment (CMA) in the Fama–French model. Cumulative values are on the vertical axis, and the horizontal axis represents the period of January 2006 to January 2019.

5. Results Discussion

Regarding the correlations between factors, this result is consistent with the findings of Fama and French (2015) and Ryan et al. (2021) that the RMW factor is negatively correlated with all factors of portfolio investment. Moreover, these results confirm the findings of the earlier work by Ryan et al. (2021). There is a high and positive correlation between HML and CMA, suggesting that companies with high B/M tend to be companies with low investment. Consistent with the previous study by Carvalho et al. (2022), the current results also show that the factors HML and market (Rm-Rf) have a significant positive correlation. Moreover, this result contradicts the findings of Fama and French (2017), who found that the RMW factor is negatively correlated with investment.

Meanwhile, our results for the Timor-Leste economy are not consistent with the findings of Zaremba et al. (2019), who found that the MKT factor has a significant negative relationship with the firm size factor. However, our results are consistent with the HML factor being negatively related to the RMW factor.

The current results show that the CAPM has successfully captured the effects of MKT risk. Extending the CAPM, the three-factor model of Fama and French (1993) introduces two additional factors, the SMB factor, and the HML factor. This result was also reported by Huang (2019). Moreover, these results for the SMB factor do not agree with the results of Huang (2019), but the results are negative and significantly the same for the value factor. For the five Fama–French factors, the results are consistent for the MKT risk factor and the HML factor, while they are not consistent for the SMB factor and the RMW factor (Huang 2019).

Likewise, these results are consistent with the application of the Fama–French model of Fang et al. (2021) with three factors in the Chinese stock market, namely that the MKT risk factor has a positive and significant effect, as well as the SMB factor and the HML factor. This result is in contrast to Kubota and Takehara (2018), who found that MKT is

significant only for the CAPM with a negative coefficient. Similarly, the HML factor was significant with positive coefficients for Fama and French's three-factor and five-factor models. The results are consistent with the findings of Richey (2017), who found that the CAPM, Fama and French's three-factor model, and Fama and French's five-factor model have a positive and significant effect. Moreover, it is consistently positive and significant only for the MKT risk factor. The SMB factor is significantly positive, and it is inconsistent with the HML factor. However, the Fama and French (2015) five-factor model shows that all factors are consistent except for the CMA factor.

It is interesting to compare these results with those of Kostin et al. (2022) on multifactor asset pricing and factor models during pandemic situations in developed and emerging markets. Timor-Leste is one of the new/emerging markets that invest their assets in the form of stocks and bonds in the markets of developed countries such as the United States (US), the United Kingdom (UK), Japan, and Germany. For these developed countries, equity investments amounted to USD 4103 million (62.7%) for the United States, USD 375 million (5.7%) for the United Kingdom, USD 540 million (8.3%) for Japan, and USD 686 million (10.5%) for Germany, which in this case is part of the European Union. Similarly, total bond investments amounted to USD 7914 million (83.1%) in the United States, USD 153 million (1.6%) in Japan, USD 164 million (1.7%) in the United Kingdom, and USD 37 million (0.4%) in Germany (Timor-Leste Ministry of Finance 2019). Thus, Timor-Leste's total equity investments contribute to corporate returns in the capital markets of these developed countries. Therefore, these results provide empirical evidence that the multifactor performance of the Fama and French (2015) five-factor model of Kostin et al. (2022) is positive and significant for all countries out of the US, UK, and Japan for MKT risk factor, except for Germany. Similarly, the SMB factor is significantly negative in line with the UK and in contrast to Japan, which is significantly negative. In addition, the HML factor is consistently significantly negative for the United States and inconsistent for Germany. In addition, the RMW factor is inconsistent for the United States and Germany, while the CMA factor is consistent in all countries, being, respectively, positive and insignificantly negative.

It is interesting to note that Timor-Leste has a Petroleum Fund, established in 2005, whose source of revenue is oil and gas. The income from this fund is invested in international capital markets such as the NASDAQ, the NYSE, the London Stock Exchange (LSE), and the Tokyo Stock Exchange. Why are these funds invested in the international capital markets? Timor-Leste is a country that does not yet have a national capital market and is therefore currently focusing on economic development. With this investment, you obtain a return every month, which fluctuates. Apart from that, petroleum money is also a source of funding for the national budget every fiscal year.

Therefore, the investment returns become a source of data for conducting research. In addition, the Fama–French dataset is used to investigate the extent to which risk factors (loading factors) affect excess returns.

For example, the results of the Fama–French five-factor model, namely the CMA factor, show that the CMA factor has a negative and non-significant influence on the excess return.

Every investor faces risk in their investments, but portfolio diversification can balance risk and return. This is because understanding risk management can help investors manage risk well, and it is the most important key to ensuring investment sustainability and mutual fund performance.

However, the results of the five Fama–French factors show that the CMA factor has a negative and insignificant impact on excess returns. However, other factors such as SMB, HML, and RMW have a significant impact and have a greater effect on investment performance. Other factors also have a varying impact on investment performance, such as the impact of global markets and global economic policies. In addition, investors analyze historical data more thoroughly by consulting financial experts or investment advisors. Thus, governments (investors) use information based on factors that ensure the sustainability of investments when making decisions. This is because investment

is becoming a source of income for economic diversification, as Timor-Leste is heavily dependent on oil and gas.

The results of this investigation will serve as a reference source for other researchers for further investigations (research gaps). This is because only sample data from Timor-Leste were used in this research. Therefore, future research can be compared with other SWFs. For example, the sample data from Timor-Leste can be compared with the sample data from other SWFs. Apart from this, the strategy of portfolio diversification in asset allocation is very different. This difference is interesting for the question of whether portfolio construction is appropriate or not. The differences in economic size and the types of funds used, such as development funds, reserve investment funds, and pension reserve funds, are also interesting. All these funds depend on the type of fundraising and sources (non-commodities, oil and gas, or minerals) of each country. All these sources depend on the individual countries. In addition, Timor-Leste's investment portfolio is unique in that it still depends on equity investments in international markets, as Timor-Leste does not yet have a national capital market. This was done to accumulate profits and diversify Timor-Leste's economy.

6. Conclusions and Policy Implications

Based on the results of the analysis and discussion of the data in the previous section, the following conclusions were drawn. This study empirically examines the CAPM, Fama and French's three-factor model, and Fama and French's five-factor model for the excess returns of Timor-Leste's equity and bond investments in the international market. The sample used includes 156 monthly excess returns over the period from 2006 to 2019. The results of the CAPM model test show that market returns have a positive and significant impact on excessive stock returns. The empirical evidence supports hypothesis H1, which states that the market factor has a positive and statistically significant impact on the excess return on equity. However, the MKT factor has a positive and significant impact on the rate of excessive stock returns in both models, i.e., the three-factor model of Fama and French and the five-factor model of Fama and French. The available empirical data support hypothesis H1, which states that the market component exerts a positive and statistically significant influence on the excess return on equity. In addition, the test results of Fama and French's three-factor model show that the SMB factor and the HML factor have a negative and significant influence on the rate of excessive stock returns. The previous findings offer empirical evidence in favor of hypotheses H2 and H3. Furthermore, the test results of Fama and French's five-factor model show that only two of the five model variables, namely the SMB factor and the HML factor, have a negative and significant impact on the rate of excess stock returns. The aforementioned findings offer empirical evidence in support of hypotheses H2 and H3. On the other hand, both the MKT risk and RMW factor variables are positively and significantly associated with excess returns. This result provides empirical support for our hypothesis H4. The CMA factor, on the other hand, has a negative and insignificant effect on excess returns. The available evidence supports the rejection of the fifth hypothesis (H5).

In summary, this analysis highlights the complexity of risk factors for excessive returns. The results show that market risks such as size and value play a crucial role in determining the excess return of Timor-Leste's portfolio investments. Therefore, the government needs to consider these aspects in their investment decisions.

The empirical results presented above are interesting and certainly have important implications for the excess return of Timor-Leste's portfolio as an emerging stock market. The significant positive and negative effects of stock and bond investments clearly show the attention of investors in investing. This also means that it will be a major investment challenge to achieve the goal of increasing the maximum equity allocation, with an expected allocation target of 40% equities and 60% bonds to achieve the target of 3% real return with reasonable probability (Timor-Leste Ministry of Finance 2019).

Investments in Timor-Leste stocks are contributions from oil revenues pooled in the Petroleum Fund and then managed for investment in a portfolio of stocks in the international market. This is because the SMB and HML factors can predict gross domestic product (GDP) growth when investing in equities, and these factors forecast future investment opportunities. Thus, this portfolio investment provides a higher return during fluctuations in economic performance (Carson 2022). To this end, oil fund managers need to diversify their portfolios into different asset classes to reduce investment risk.

Fund managers managing petroleum fund portfolios in the form of stocks and bonds need to pay attention to the SMB factor in terms of investment performance, where small companies outperform larger companies over the long term. This phenomenon suggests that the performance of small companies in the stock market may be a predictor of the future performance of a low-beta-against-beta strategy. Thus, it is the short-term performance of small companies and funding liquidity that affects the profitability of the low-beta strategy, which ultimately leads to low or negative returns for the low-beta security class (Zaremba 2020). The same was also found by Ji et al. (2020), who state that the size effect is that the returns of small listed companies are on average much higher than those of large companies. Still, for the same researchers, the effect of BM shows that stock returns have a positive relationship with the book-to-market ratio of the company. A higher book-to-market ratio can lead to a higher stock return. In addition, Hu et al. (2019) found that a strong size effect means that smaller companies have higher returns on average than larger companies.

Managers need to understand information about portfolio market activity when managing investments and macroeconomic risks to deal with increasing unsystematic and systematic risks in portfolio investments. Therefore, managers need to understand the relationship between stock market volatility and macroeconomic forces in policy making. For example, stock price movements in economic activity, especially in portfolio investing, are influenced by macroeconomic variables such as inflation in predicting excess returns, especially directional relationships with variables that interact with each other (de Jesus et al. 2020). In addition, investment managers need to understand the balance of values of expected cash flows when forecasting interest rate fluctuations that affect changes in stock prices. This is because high interest rates affect excessive returns on portfolio investments, i.e., when cash flows are capitalized. It is interesting to make income securities an alternative investment necessary for holding equity investments. Similarly, high interest rates can affect investment costs, making investors less willing to borrow and make portfolio investments. This also affects the value of future cash flows and ultimately leads to a decline in stock prices (Tiwari et al. 2022). In addition, investment managers need to understand monetary policy, even though Timor-Leste is still dependent on US monetary policy, especially the official use of the dollar in the economy, where the contribution of the policy of rising interest rates affects the rise of the stock market, which in turn has ultimately disrupted economic activity due to greater inflationary pressures, such as the current war between Russia and Ukraine.

Based on our findings described in the conclusion and policy implications, we summarize and recommend the following policy actions as a good basis for portfolio investment decision making:

1. The Petroleum Fund invests in Timor-Leste bonds and equities on the international markets intending to accumulate capital. This capital is used for economic diversification to increase GDP growth. Therefore, to reduce investment risks, the government needs to diversify its portfolio into different asset classes.
2. Fund managers should consider the SMB factor for petroleum fund portfolios, as smaller companies often outperform larger companies, possibly indicating the future performance of a low-beta-against-beta approach.
3. To properly manage assets, managers must have a comprehensive understanding of market activity and macroeconomic risks in the portfolio.

4. Fund managers need to have insights into the correlation between stock market volatility and macroeconomic factors, which are essential for policy decisions, especially for predicting excess returns.
5. Investment managers need to consider the balance of expected cash flows when forecasting interest rate fluctuations, as high-interest rates can affect excessive returns on portfolio investments and reduce investors' appetite for portfolio investments.
6. Investment managers need to understand the monetary policy in Timor-Leste, which is heavily influenced by US monetary policy, specifically the dollar. This has resulted in higher inflationary pressures and disruptions in economic activity.

Timor-Leste, as a recent or new economy (emerging country), participates in equity investments in international markets. This is the first article that uses the Fama and French (2015) five-factor model and the three-factor model of Fama and French (1993) in equity portfolio investment for the country. For this reason, this research is limited to using the excess returns of equity investments in the form of stocks and bonds as invested in model markets in various countries such as the US, the UK, Japan, and Australia. It is hoped that further researchers will add other variables such as momentum and quality and use the names of listed companies and make Timor-Leste's investment portfolios comparable between developing and developed countries since Timor-Leste itself does not yet have a national capital market.

Author Contributions: F.A. was responsible for conceptualization, data curation, formal analysis, investigation, methodology, and roles/writing—original draft. M.M. was responsible for investigation, methodology, project administration, resources, software, supervision, validation, visualization, roles/writing—original draft, and writing—review and editing. E.V. was responsible for resources, software, supervision, validation, visualization, roles/writing—original draft, and writing—review and editing. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: We confirm that the data sources described in the methodology were used. Monthly data on equity and bond returns are provided by the Office of Policy and Management of Petroleum Funds, Ministry of Finance of Timor-Leste, where the data can be accessed in Excel and the Fama–French and CAPM models from Kenneth R. French—Data Libraries. The Excel data are available upon request from the first author.

Acknowledgments: This work was financially supported by the Research Unit on Governance, Competitiveness and Public Policies (UIDB/04058/2020) + (UIDP/04058/2020), funded by national funds through FCT—Fundação para a Ciência e a Tecnologia. The authors acknowledge the valuable comments of both the editor and reviewers.

Conflicts of Interest: The authors declare no conflict of interest.

Abbreviations

The following abbreviations are used in this manuscript:

AFP	Asness, Frazzini, and Pederson model
AMEX	American Express
B/M	Book-to-market ratio
BE/ME	Book equity to market equity
CAPM	Capital asset pricing model
CMA	Conservative Minus Aggressive
FF5	Fama–French five-factor model
GDP	Gross domestic product
HML	High Minus Low
INV	Investment by market

ME	Market equity
MENA	Middle East and North Africa
MKT	Market risk premium
MOM	Momentum factor
MPT	Modern portfolio theory
NASDAQ	National Association of Securities Dealers Automated Quotations
NEP	Non-negative equity premium
NYSE	New York Stock Exchange
OLS	Ordinary least squares
P	Profitability
RMW	Robust Minus Weak
SMB	Small Minus Big
SSA	Sub-Saharan African countries
UK	United Kingdom
US	United State
USD	United States dollar

References

Ali, Fahad, Muhammad U. Khurram, and Yuexiang Jiang. 2021. The Five-factor asset pricing model tests and profit-ability and investment premiums: Evidence from Pakistan. *Emerging Markets Finance and Trade* 57: 2651–73. [CrossRef]

Ali, Fahad, Rongrong He, and Yuexiang Jiang. 2018. Size, value and business cycle variables. the three-factor model and future economic growth: Evidence from an emerging market. *Economies* 6: 14. [CrossRef]

Alqadhib, Haidar, Nada Kulendran, and Lalith Seelanatha. 2022. Impact of COVID-19 on mutual fund performance in Saudi Arabia. *Cogent Economics & Finance* 10: 2056361. [CrossRef]

Anjum, Nadia, and Suresh K. O. Rajput. 2021. Forecasting islamic equity indices alpha. *International Journal of Islamic and Middle Eastern Finance and Management* 14: 183–203. [CrossRef]

Aygoren, Hakan, and Emrah Balkan. 2020. The role of efficiency in capital asset pricing: A research on nasdaq tech-nology sector. *Managerial Finance* 46: 1479–93. [CrossRef]

Bank, Matthias, and Franz Insam. 2019. Risk premium contributions of the Fama and French mimicking factors. *Finance Research Letters* 29: 347–56. [CrossRef]

Banz, Rolf W. 1981. The relationship between return and market value of common stocks. *Journal of Financial Eco-Nomics* 9: 3–18. [CrossRef]

Bartram, Söhnke M., Harald Lohre, Peter F. Pope, and Ananthalakshmi Ranganathan. 2021. Navigating the factor zoo around the world: An institutional investor perspective. *Journal of Business Economics* 91: 655–703. [CrossRef]

Bessler, Wolfgang, Georgi Taushanov, and Dominik Wolff. 2021. Factor investing and asset allocation strategies: A comparison of factor versus sector optimization. *Journal of Asset Management* 22: 488–506. [CrossRef]

Boussaidi, Ramzi, and Majid I. AlSaggaf. 2022. Contrarian profits and representativeness heuristic in the MENA stock markets. *Journal of Behavioral and Experimental Economics* 97: 101820. [CrossRef]

Carson, Scott A. 2022. Long-term daily equity returns across sectors of the oil and gas industry, 2000–2019. *Journal of Industry, Competition and Trade* 22: 125–43. [CrossRef]

Carvalho, Gabriel A., Hudson F. Amaral, Juliano L. Pinheiro, and Laíse F. Correia. 2022. Pricing of liquidity risk: New evidence from the Latin American emerging stock markets. *Emerging Markets Finance and Trade* 58: 398–416. [CrossRef]

Chai, Daniel, Mardy Chiah, and Angel Zhong. 2019. Choosing factors: Australian evidence. *Pacific Basin Finance Journal* 58: 101223. [CrossRef]

Cox, Shaun, and James Britten. 2019. The Fama-French five-factor model: Evidence from the Johannesburg stock exchange. *Investment Analysts Journal* 48: 240–61. [CrossRef]

Dichtl, Hubert, Wolfgang Drobetz, and Viktoria S. Wendt. 2021. How to build a factor portfolio: Does the allocation strategy matter? *European Financial Management* 27: 20–58. [CrossRef]

Dirkx, Philipp, and Franziska J. Peter. 2020. The Fama-French five-factor model plus momentum: Evidence for the German market. *Schmalenbach Business Review* 72: 661–84. [CrossRef]

Doraisami, Anita. 2018. The Timor Leste petroleum fund, veterans and white elephants: Fostering intergenerational equity? *Resources Policy* 58: 250–56. [CrossRef]

Ekaputra, Irwan A., and Bambang Sutrisno. 2020. Empirical tests of the Fama-French five-factor model in Indonesia and Singapore. *Afro-Asian Journal of Finance and Accounting* 10: 85–111. [CrossRef]

Fama, Eugene F., and James D. MacBeth. 1973. Risk, return, and equilibrium: Empirical tests. *Journal of Political Economy* 81: 607–36. [CrossRef]

Fama, Eugene F., and Kenneth R. French. 1992. The cross-section of expected stock returns. *The Journal of Finance* 47: 427–65. [CrossRef]

Fama, Eugene F., and Kenneth R. French. 1993. Common risk factors in the returns on stocks and bonds. *Journal of Financial Economics* 33: 3–56. [CrossRef]

Fama, Eugene F., and Kenneth R. French. 2012. Size, value, and momentum in international stock returns. *Journal of Financial Economics* 105: 457–72. [CrossRef]
Fama, Eugene F., and Kenneth R. French. 2015. A five-factor asset pricing model. *Journal of Financial Economics* 116: 1–22. [CrossRef]
Fama, Eugene F., and Kenneth R. French. 2017. International tests of a five-factor asset pricing model. *Journal of Financial Economics* 123: 441–63. [CrossRef]
Fama, Eugene F., and Kenneth R. French. 2018. Choosing factors. *Journal of Financial Economics* 128: 234–52. [CrossRef]
Fama, Eugene F., and Kenneth R. French. 2020. Comparing cross-section and time-series factor models. *Review of Financial Studies* 33: 1891–926. [CrossRef]
Fang, Tong, Zhi Su, and Libo Yin. 2021. Does the green inspiration effect matter for stock returns? Evidence from the Chinese stock market. *Empirical Economics* 60: 2155–76. [CrossRef]
Hasler, Michael, and Charles Martineau. 2022. Equity return predictability with the ICAPM. *SSRN Electronic Journal*, 1–37. Available online: https://papers.ssrn.com/abstract=3368264 (accessed on 3 November 2023).
Hens, Thorsten, and Fatemeh Naebi. 2021. Behavioural heterogeneity in the capital asset pricing model with an application to the low-beta anomaly. *Applied Economics Letters* 28: 501–7. [CrossRef]
Horváth, Dominik, and Yung-Lin Wang. 2021. The examination of Fama-French model during the COVID-19. *Finance Research Letters* 41: 101848. [CrossRef]
Hu, Grace X., Can Chen, Yuan Shao, and Jiang Wang. 2019. Fama–French in China: Size and value factors in Chinese stock returns. *International Review of Finance* 19: 3–44. [CrossRef]
Huang, Tzu-Lun. 2019. Is the Fama and French five-factor model robust in the Chinese stock market? *Asia Pacific Management Review* 24: 278–89. [CrossRef]
Hundal, Shab, Anne Eskola, and Doan Tuan. 2019. Risk–return relationship in the Finnish stock market in the light of capital asset pricing model (CAPM). *Journal of Transnational Management* 24: 305–22. [CrossRef]
Hung, Phan T. M., Tran T. T. Dai, Phan N. B. Quynh, Le D. Toan, and Vo H. D. Trinh. 2019. The relationship between risk and return—An empirical evidence from real estate stocks listed in Vietnam. *Asian Economic and Financial Review* 9: 1211–26. [CrossRef]
Jareño, Francisco, María de la O. González, and Alba M. Escolástico. 2020. Extension of the Fama and French model: A study of the largest European financial institutions. *International Economics* 164: 115–39. [CrossRef]
de Jesus, Carlos, Gizelle D. Willows, and Alison M. Olivier. 2020. The influence of the market on inflation, not the other way around. *Investment Analysts Journal* 49: 79–91. [CrossRef]
Ji, Ziyang, Victor Chang, Hao Lan, Ching H. R. Hsu, and Raul Valverde. 2020. Empirical research on the Fama-French three-factor model and a sentiment-related four-factor model in the Chinese blockchain industry. *Sustainability* 12: 5170. [CrossRef]
John, Samuel, Elissaios Papyrakis, and Luca Tasciotti. 2020. Is there a resource curse in Timor-Leste? A critical re-view of recent evidence. *Development Studies Research* 7: 141–52. [CrossRef]
Kaya, Emine. 2021. Relative performances of asset pricing models for BIST 100 index. *Revista Espanola de Financiacion y Contabilidad* 50: 280–301. [CrossRef]
Kazmi, Madiha, Umara Noreen, Imran A. Jadoon, and Attayah Shafique. 2021. Downside beta and downside gam-ma: In search for a better capital asset pricing model. *Risks* 9: 223. [CrossRef]
Kostin, Konstantin B., Philippe Runge, and Michel Charifzadeh. 2022. An analysis and comparison of multi-factor asset pricing model performance during pandemic situations in developed and emerging markets. *Mathematics* 10: 142. [CrossRef]
Kubota, Keiichi, and Hitoshi Takehara. 2018. Does the Fama and French five-factor model work well in Japan? *International Review of Finance* 18: 137–46. [CrossRef]
Kynigakis, Iason, and Ekaterini Panopoulou. 2022. Does model complexity add value to asset allocation? Evidence from machine learning forecasting models. *Journal of Applied Econometrics* 37: 603–39. [CrossRef]
Lalwani, Vaibhav, and Madhumita Chakraborty. 2020. Multi-factor asset pricing models in emerging and developed markets. *Managerial Finance* 46: 360–80. [CrossRef]
Levy, Moshe. 2022. An inter-temporal CAPM based on first order stochastic dominance. *European Journal of Operational Research* 298: 734–39. [CrossRef]
Lintner, John. 1965. The valuation of risk assets and the selection of risky investments in stock portfolios and capital budgets. *The Review of Economics and Statistics* 47: 13. [CrossRef]
Liu, Hao, Hao Zhang, Ya C. Gao, and Xu D. Chen. 2022. Firm age and beta: Evidence from China. *International Review of Economics and Finance* 77: 244–61. [CrossRef]
Lone, Umer M., Mushtaq A. Darzi, and Khalid U. Islam. 2021. Macroeconomic variables and stock market performance: A PMG/ARDL approach for BRICS economies. *Macroeconomics and Finance in Emerging Market Economies* 16: 300–25. [CrossRef]
Lopes, Helder. 2021. Timor-Leste to Graduate from LDC Category and Beyond: Through Structural Transformation and Economic Diversification. ESCAP Working Paper Series. pp. 1–51. Available online: https://repository.unescap.org/handle/20.500.12870/3689 (accessed on 1 November 2023).
López-García, María Nieves, J. E. Trinidad-Segovia, M. A. Sánchez-Granero, and Igor Pouchkarev. 2021. Extending the Fama and French model with a long term memory factor. *European Journal of Operational Research* 291: 421–26. [CrossRef]
Maneemaroj, Panutat, Ravi Lonkani, and Chanon Chingchayanurak. 2021. Appropriate expected return and the relationship with risk. *Global Business Review* 22: 865–78. [CrossRef]

Markowitz, Harry. 1952. Portfolio Selection. *Journal of Finance* 7: 77–91.
Mohanty, Subhransu S. 2019. Does one model fit all in global equity markets? some insight into market factor based strategies in enhancing alpha. *International Journal of Finance and Economics* 24: 1170–92. [CrossRef]
Mosoeu, Selebogo, and Odongo Kodongo. 2020. The Fama-French five-factor model and emerging market equity returns. *Quarterly Review of Economics and Finance* 85: 55–76. [CrossRef]
Mossin, Jan. 1966. Equilibrium in a capital asset market. *Econometrica* 34: 768–83. Available online: http://www.jstor.org/stable/1910098 (accessed on 2 April 2022).
Nazaire, Gregory, Maria Pacurar, and Oumar Sy. 2020. Betas versus characteristics: A practical perspective. *European Financial Management* 26: 1385–413. [CrossRef]
Nichol, Eoghan, and Michael Dowling. 2014. Profitability and investment factors for UK asset pricing models. *Economics Letters* 125: 364–66. [CrossRef]
Pandey, Asheesh, and Rajni Joshi. 2021. Examining asset pricing anomalies: Evidence from Europe. *Business Perspectives and Research* 10: 362–78. [CrossRef]
Richey, Greg. 2017. Fewer reasons to sin: A five-factor investigation of vice stock returns. *Managerial Finance* 43: 1016–33. [CrossRef]
Rojo-Suárez, Javier, Ana B. Alonso-Conde, and Ricardo Ferrero-Pozo. 2022. Liquidity, time-varying betas and anom-alies: Is the high trading activity enhancing the validity of the CAPM in the UK equity market? *International Journal of Finance and Economics* 27: 45–60. [CrossRef]
Roy, Rahul. 2021. A six-factor asset pricing model: The Japanese evidence. *Financial Planning Review* 4: 1–18. [CrossRef]
Ryan, Nina, Xinfeng Ruan, Jin E. Zhang, and Jing A. Zhang. 2021. Choosing factors for the Vietnamese stock market. *Journal of Risk and Financial Management* 14: 96. [CrossRef]
Sahabuddin, Mohammad, Md A. Islam, Mosab I. Tabash, Suhaib Anagreh, Rozina Akter, and Md M. Rahman. 2022. Co-movement, portfolio diversification, investors' behavior and psychology: Evidence from developed and emerging countries' stock markets. *Journal of Risk and Financial Management* 15: 319. [CrossRef]
Saiti, Buerhan, Yusuf Ma, Ruslan Nagayev, and İbrahim G. Yumusak. 2020. The diversification benefit of Islamic investment to Chinese conventional equity investors: Evidence from the multivariate GARCH analysis. *International Journal of Islamic and Middle Eastern Finance and Management* 13: 1–23. [CrossRef]
Scheiner, Charles. 2021. Timor-Leste economic survey: The end of petroleum income. *Asia and the Pacific Policy Studies* 8: 253–79. [CrossRef]
Sehrawat, Neeraj, Amit Kumar, Narander K. Nigam, Kirtivardhan Singh, and Khushi Goyal. 2020. Test of capital market integration using Fama-French three-factor model: Empirical evidence from India. *Investment Management and Financial Innovations* 17: 113–27. [CrossRef]
Shaikh, Salman A., Mohd A. Ismail, Abdul G. Ismail, Shahida Shahimi, and Muhammad H. Muhammad. 2019. Cross section of stock returns on Shari'ah-compliant stocks: Evidence from Pakistan. *International Journal of Islamic and Middle Eastern Finance and Management* 12: 282–302. [CrossRef]
Sharma, Prateek, and Vipul. 2018. Improving portfolio diversification: Identifying the right baskets for putting your eggs. *Managerial and Decision Economics* 39: 698–711. [CrossRef]
Sharpe, William F. 1964. A theory of market equilibrium under conditions of risk. *The Journal of Finance* 19: 425–42.
Silva, Sabrina E., Carolina M. S. Roma, and Robert A. Iquiapaza. 2020. Portfolio turnover and performance of equity investment funds in Brazil. *Revista Contabilidade & Finanças* 31: 332–47. [CrossRef]
Taib, Asmâa A., and Safae Benfeddoul. 2023. The empirical explanatory power of CAPM and the Fama and French Three-Five Factor Models in the Moroccan Stock Exchange. *International Journal of Financial Studies* 11: 47. [CrossRef]
Taussig, Roi D. 2022. New evidence on practical implications of the CAPM: In memory of Simon Benninga. *Journal of Corporate Accounting and Finance* 33: 72–77. [CrossRef]
Timor-Leste Ministry of Finance. 2019. Timor-Leste Petroleum Fund—Annual Report 2019. Available online: https://www.bancocentral.tl/uploads/documentos/documento_1600057279_4497.pdf (accessed on 20 February 2022).
Tiwari, Aviral K., Ibrahim D. Raheem, Seref Bozoklu, and Shawkat Hammoudeh. 2022. The oil price-macroeconomic fundamentals nexus for emerging market economies: Evidence from a wavelet analysis. *International Journal of Finance and Economics* 27: 1569–90. [CrossRef]
Wang, Ching-Ping, Hung H. Huang, and Jin S. Hu. 2017. Reverse-engineering and real options–adjusted CAPM in the Taiwan stock market. *Emerging Markets Finance and Trade* 53: 670–87. [CrossRef]
Yamaka, Woraphon, and Rungrapee Phadkantha. 2021. A convex combination approach for artificial neural net-work of interval data. *Soft Computing* 25: 7839–51. [CrossRef]
Yunus, Nafeesa. 2020. Time-varying linkages among gold, stocks, bonds and real estate. *Quarterly Review of Economics and Finance* 77: 165–85. [CrossRef]
Zaimovic, Azra, Adna Omanovic, and Almira Arnaut-Berilo. 2021. How many stocks are sufficient for equity portfolio diversification? A Review of the Literature. *Journal of Risk and Financial Management* 14: 551. [CrossRef]
Zaremba, Adam. 2020. Small-minus-big predicts betting-against-beta: Implications for international equity alloca-tion and market timing. *Investment Analysts Journal* 49: 322–41. [CrossRef]

Zaremba, Adam, Anna Czapkiewicz, Jan J. Szczygielski, and Vitaly Kaganov. 2019. An application of factor pricing models to the Polish stock market. *Emerging Markets Finance and Trade* 55: 2039–56. [CrossRef]
Zhang, Tianyang, and Sergio H. Lence. 2022. Liquidity and asset pricing: Evidence from the Chinese Stock Markets. *North American Journal of Economics and Finance* 59: 101557. [CrossRef]