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Evaluation of the Resilience of Real Estate and Property Stocks to Inflation and Interest Rate Uncertainty: Implementation of Two Asset Pricing Models

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Abstract: Property stocks are an attractive alternative investment for investors who want passive income. Investors' decisions focus not only on maximizing returns but also on reducing risk. This study examines the extent to which macroeconomic factors affect stock performance by comparing the effectiveness of the Fama–French five-factor model (5FF) and Fama–French seven-factor model (7FF) in estimating returns. This study also verifies Fisher's theory in the context of property and real estate stocks. The research data used are property and real estate stocks in the Indonesian capital market. The data are processed using the OLS estimation method, and Akaike's Information Criterion (AIC) is used to choose the optimal model. The results show that property and real estate stocks in Indonesia with negative profitability at all quantiles can hedge inflation and interest rates. However, the interest rates are not the only factor affecting the market risk. The 7FF model is better at explaining the variability of stock portfolio returns. This research makes an essential contribution to the financial literature in Indonesia, particularly in the context of portfolio management in the property and real estate sector.

Keywords: property and real estate stocks; stock returns; Fama–French five-factor model; Fama–French seven-factor model; Indonesian capital market

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1. Introduction

Property and real estate shares are a type of liquid security that allows investors to access and engage in the property market without the need to trade physical assets. Property sector stocks are an attractive alternative investment option for investors seeking passive income, diversification, and long-term growth potential (Rees and Selcuk-kestel 2014; J. Zhou 2013). Regarding return risk, property and real estate investments outperform other investments (Yiu et al. 2022).

The property and real estate sector is currently under pressure from negative sentiment caused by rising interest rates and inflation. The 25 basis points (bps) increase in Bank Indonesia's benchmark interest rate to 6.25% has put pressure on property and real estate companies. Property and real estate issuers are sensitive to interest rate movements and people's purchasing power. Thus, when pressure from an increase in interest rates increases, market participants will respond negatively (Nityakanti and Perwitasari 2024). Meanwhile, annual inflation in Indonesia increased from 2.75% in February to 3.05% in March 2024, exceeding the forecast of 2.91%. Despite thise rise in inflation, the figure remains within Bank Indonesia's target range of 1.5% to 3.5% (PT Bank Maybank Indonesia 2024). Interest rates are another factor that indicates changes in property and real estate stock prices (Liow et al. 2006; Ito 2013). Andrieș et al. (2014) identified a connection between stock prices and interest rates. Fluctuations in interest rates significantly explain the variability of financial stock returns (Zhu 2007). Bartram (2002) and Jareño (2008) identify a negative and statistically significant relationship between nominal interest rates and stock returns in the non-financial sector. This relationship between interest rates and returns is related to a firm's ability to pass on the impact of inflation, as the sensitivity of stock returns to changes in interest rates tends to be lower in firms that are better able to transfer changes in inflation to stock prices (Jareño and Navarro 2010). Pesci et al. (2022) argue that market participants' inflation expectations are non-linear and follow a regime change process. This analysis is grounded in the notion that inflation expectations can heavily influence asset prices during heightened uncertainty and concern about inflation. However, in periods of more stable inflation expectations, inflation becomes less of a focal issue, as its impact is less pronounced.

Akinsomi et al. (2017); and Fasanya and Adekoya (2022) concluded that the market is susceptible to various forms of risk, including interest rate and inflation risks. The unpredictability of interest rates and inflation risks contributes to the uncertainty of property and real estate stock returns. Research by Liow et al. (2006) and Xiao et al. (2014) focuses on the relationship between macroeconomic risk and the rate of return of Real Estate Investment Trusts (REITs). A REIT (Real Estate Investment Trust) is a company that owns, operates, or finances income-producing real estate and allows investors to pool their capital to invest in a diversified portfolio of real estate assets. It represents a type of liquid asset class that provides investors with access to and participation in the relatively illiquid real estate market without the need to engage in direct real estate transactions or trading REITs across different countries (Mpofu et al. 2023). They found evidence that REIT's risk varies over time and is dynamically related to macroeconomic risk. The findings are supported by research by Gascon and Jacob (2020), which proves that macroeconomic uncertainty also causes delays and cancellations in real estate purchase transactions in the United States. Several other studies have also found various macroeconomic risks affecting the market, such as exchange rate risk (Kodongo and Ojah 2014; Kola and Kodongo 2017; Wang et al. 2017), interest rate risk (Ekaputra and Sutrisno 2020; Liow et al. 2006; Akinsomi et al. 2017), and inflation rate risk (Munk et al. 2004).

Investors' investment decisions focus on maximizing returns and reducing risk. Significant changes in macroeconomic conditions and their effect on market expectations can directly affect asset returns. Inflation predictions are closely related to the sales and profitability of companies targeted for investment, and they are often an essential factor in investment decision-making in the capital market (Pesci et al. 2022).

Inflation is one of the main risks that investors face, as it can erode the real return on investment. When inflation erodes purchasing power, increased property and real estate investment can hedge against this inflationary pressure (Fang et al. 2008; Zhou and Clements 2010). Property and real estate stock dividend growth is expected to exceed inflation. Therefore, Coën et al. (2023) highlighted the significance of public real estate markets in portfolio diversification. Property and real estate stocks have historically been considered solid assets and adequate protection against inflation (Erol and Tirtiroglu 2008; Pesci et al. 2022). These findings are in line with Fisher's theory (1930). Fisher (1930) stated that nominal interest rate expectations should move in the same direction as inflation expectations. Fisher's theory suggests that an investment asset's expected nominal interest rate should equal the sum of expected inflation and the anticipated real return, with the actual return being unaffected by inflation (Fama and Schwert 1977). Property and real estate have historically been favored investments, particularly in high-inflation economies because they serve as a hedge against inflation (Erol and Tirtiroglu 2008).

Real Estate Investment Trusts (REITs) have established a prominent position within financial markets, representing a distinct asset class that contributes to a well-balanced investment portfolio through securitized liquidity (Akinsomi et al. 2017) and diversification opportunities (Kola and Kodongo 2017). Consequently, it is unsurprising that the REIT market has witnessed remarkable growth in recent years (Fasanya and Adekoya 2022). Research on property and real estate in the Indonesian capital market is becoming increasingly relevant as the property sector develops and investor interest in real asset-based investment instruments increases. Research by Gamal et al. (2023) shows that the pandemic's impact on the economy has led to stagnation in the property market. In its findings, property and real estate market players in Indonesia have reported decreased demand for high-rise residential buildings, thus affecting housing preferences. Factors influencing thise phenomenon during the pandemic are the fear of meeting other people and the fear of recession. At the same time, Razali et al. (2020) examine the dynamics of risk-adjusted performance in property and real estate stocks in the Malaysian capital market. In reality, stocks with higher returns have higher risks than stocks before the global financial crisis. During the financial crisis, property stocks did not provide risk-adjusted returns. The impact of the economic crisis on property stocks proves that the selection of outperforming stocks can increase diversification benefits and solid portfolio returns.

Several studies have shown that property and real estate stocks tend to be vulnerable to fluctuations in interest rates and inflation. Therefore, a model is needed to measure the risk and return investors expect when choosing an appropriate portfolio. Some asset pricing models, including the Capital Asset Pricing Model (CAPM), the Fama–French five-factor model (5FF), the Consumption Capital Asset Pricing Model (CCAPM), and the Intertemporal Capital Asset Pricing Model (ICAPM), exclude property and real estate assets primarily because of their volatile and illiquid characteristics (Yiu et al. 2022). However, research by Coskun et al. (2017) shows that the models are still relevant, as evidenced in the analysis of increasing returns of REITs in Turkey using the CAPM and the Fama–French (3FF) three-factor model. Although the 3FF model (plus political risk, currency risk, and global crisis factors) is superior to the CAPM, its ability to explain Turkish REIT returns' variability still needs to be improved. Therefore, this study uses the latest model from Fama–French, namely, the Fama–French five-factor model (referred to as the 5FF model). The Fama–French five-factor model, introduced by Fama and French (2015), is a combination of market, size, value growth, profitability, and investment factors.

Fama and French (2015) grouped stocks into portfolios and examined the returns of these portfolios. The 5FF model has been widely used by researchers to analyze risk and return (Chiah et al. 2016; Foye 2018; Sutrisno et al. 2016; Huang 2019; Yiu et al. 2022). One exciting aspect of the 5FF model in a global context is that its performance varies from region to region (Fama and French 2016).

The property and real estate sector is often affected by macroeconomic factors such as interest rates and inflation. Differences in regional economic conditions mean that the importance of certain factors can differ between regions. In Indonesia, the property and real estate sector is highly dependent on monetary policy and macroeconomic dynamics, which require a comprehensive analytical approach. Therefore, this study proposes the use of the Fama–French five-factor model, which is extended to the Fama–French seven-factor model (7FF) with the inclusion of interest rates and inflation. By incorporating these macroeconomic variables, the 7FF model provides a more holistic perspective on investment risk and return potential, assisting investors in making more informed investment decisions in the property and real estate sector. As an alternative option, this research also offers an innovative approach.

The addition of interest rates and inflation to the five-factor Fama–French model, thus forming the Fama–French seven-factor model (7FF), is based on Fisher's (1930) theory. Fisher's (1930) theory is an economic principle that states that the expected nominal interest rate is a combination of the expected real interest rate and the expected inflation rate. This financial concept is interesting, as the nominal interest rate will increase as expected inflation increases, while the real interest rate remains unchanged. Actual interest rates are considered independent of inflation, reflecting compensation to investors for using their capital.

In contrast, nominal interest rates include additional compensation for losing purchasing power due to inflation. This research is fundamental, as it integrates the latest Fama–French model with Fisher's (1930) theory and changes the empirical model specification. In addition, testing finance theory using data in developing countries such as Indonesia still needs to be improved. This research is expected to improve the shortcomings of previous studies by presenting a more comprehensive analysis of the impact of interest rates and inflation on stock returns in the property and real estate sectors.

This study aims to (1) examine the extent to which macroeconomic factors affect the performance of property and real estate stocks; (2) compare the effectiveness of the 5FF and 7FF models in estimating property and real estate stock returns; (3) verify Fisher's theory in the context of property and real estate stocks. The main contributions of this research are the following: (1) This model is expected to be a more appropriate tool for investors in assessing the risk and return of stocks in the property and real estate sector in developing countries such as Indonesia; (2) This model is expected to provide an academic contribution by integrating Fisher's theory into asset pricing models. By including interest rates and inflation as additional factors, this research validates the relevance of Fisher's theory in the context of the property and real estate stock market in Indonesia, strengthening the understanding of the relationship between macroeconomic variables and stock returns; (3) This model makes an essential contribution by evaluating the performance of the 7FF model in the context of regional macroeconomics in Indonesia. This research helps identify significant macroeconomic factors in Indonesia, providing insights for policymakers and investors regarding the impact of interest rates and inflation on property and real estate markets; (4) This research fills a gap in the existing literature by focusing on property and real estate stocks, often neglected in asset pricing models. By providing an in-depth analysis of how interest rates and inflation affect returns in this sector, this study offers a new perspective that can enrich investment literature and practices in Indonesia; (5) The results of this study make a practical contribution by providing better guidance for investors and portfolio managers in managing risk and maximizing returns in the property and real estate sector so that they can make more informed and strategic investment decisions.

The effect of inflation and interest rates on portfolio returns is assessed using the 5FF and 7FF models. The results showed that the 7FF model better explains the variability of stock portfolio returns in the property and real estate sector than the 5FF model. The 7FF model adds macroeconomic risk as an additional factor and provides a deeper insight into the determinants of stock returns, as seen from the increase in R^2 value and a low AIC value. Interest rates and inflation significantly contribute to the 7FF model, suggesting that adding macroeconomic factors enriches the risk and return analysis. Thise research also concludes that property and real estate stocks in Indonesia with negative profitability across all quintiles can be a hedge against inflation and interest rates. It shows that interest rates are not the only factor affecting market risk.

This research is organized as follows: Section 2 discusses the literature review; Section 3 outlines the data, research model, research methods, and portfolio construction; Section 4 presents the research results; Section 5 covers the discussion; and Section 6 contains the conclusion.

2. Literature Review

Property and real estate shares are liquid assets that enable investors to engage in capital markets without the need to trade physical assets (Kola and Kodongo 2017; Zhu 2018; Edil et al. 2020). The property and real estate sector in the Indonesian capital market shows high sensitivity to increases in inflation and interest rates, which have an impact on people's purchasing power (Melani 2024). Several empirical studies have reinforced the relationship between macroeconomic variables and stock returns, although the results remain varied and inconsistent. Research (Czapkiewicz et al. 2018; Park et al. 2019; Fasanya and Adekoya 2022) concluded that financial and stock markets rely on macroeconomic indicators such as Gross Domestic Product (GDP), interest rates, inflation rates, and industrial production. Macroeconomic factors are crucial predictors for the REIT market. Song et al. (2018) demonstrate that China's stock market volatility has vigorously responded to macroeconomic uncertainty. In contrast, in the United States, there is a solid two-way link between capital markets and macroeconomic factors. This interaction is based on the theory developed by Ross (1976), the Arbitrage Pricing Theory (APT). The APT predicts that if markets are efficient, any changes in macroeconomic variables will directly or indirectly affect firms' expected cash flows, funding decisions, and investments (Ross 1976; Chinzara 2011; Fama and French 2015). As a result, changes in the profitability of a listed firm will subsequently influence overall stock market returns. The APT models asset returns as a linear function of various macroeconomic risks, with sensitivities to these factors represented by coefficients in a multivariate regression framework (Bhuiyan and Chowdhury 2019). When viewed from a methodological point of view, the research results related to macroeconomics' influence on stock returns need to be more consistent.

2.1. Fisher's Theory (1930)

The basic theory linking stock returns to inflation is related to Fisher's theory. Fisher (1930) proposed that the expected nominal return on common stock comprises the actual return and the expected inflation rate. In this framework, the Fisher effect signifies arbitrage between financial and tangible assets within a country. As inflation expectations rise, investors move their investments from financial to tangible assets. Based on Fisher's theory, stocks are considered hedging instruments against inflation, as they reflect claims on tangible assets, which indicates that stock prices should be positively correlated with inflation expectations.

However, empirical testing of the generalized Fisher theory yields mixed findings. Many studies provide evidence contrary to the theory, demonstrating that expected inflation, changes in expected inflation, and unexpected inflation are negatively correlated with stock returns (Bodie 1976; Fama and Schwert 1977; Gultekin 1983; Solnik 1983; Lee 1992). However, Kaul (1987) and Boudoukh and Richard (1983) reported that Fisher's theory is accepted when stock returns and inflation is analyzed over a long period. Firth (1979) and Gultekin (1983) found a positive relationship between stock returns and inflation in the UK during the immediate post-war years consistent with the generalized Fisher theory. Most empirical studies on Fisher's theory primarily focus on the US and European economies, with some also examining Japan. The US is often used as the primary sample in testing the Fisher effect, as it has a developed financial sector and easy data availability for research. Some researchers argue that, in the short run, especially during fluctuations, the Fisher effect may not fully hold, but it tends to be more relevant in the long run. With new econometric techniques that examine long-run cointegration relationships between time series, testing for the Fisher effect has come back into focus, as it has important implications for macroeconomics.

2.2. The Role of Inflation in Investment and Capital Markets

Inflation significantly impacts individual investors, especially those who want to align finances with investments. To mitigate inflation risk, investors look for opportunities by including property and real estate stocks in a diversified portfolio. Property and real estate stocks are considered an effective inflation hedge and important in institutional investors' portfolios. Fisher (1930) concluded that the real sector and the monetary economy are mainly independent. Therefore, natural factors such as capital productivity, investors' time preference, and risk appetite determine the expected real return. The expected return and inflation rates are unrelated and change over time (Li and Zhao 2019).

Alexakis et al. (1991) argued that inflation volatility affects stock prices, especially in emerging markets. Higher inflation rates correlate with less liquid and smaller stock markets. Conversely, countries that experience low inflation rates have stable stock prices, especially in capital markets. Some research (Reddy (2012) in India; Adusei (2014) in Ghana; Silva (2016) in Sri Lanka) concluded that emerging capital markets are essentially negatively impacted by inflation. The challenges faced due to inflationary pressures focus on investors' reliance on predictions of economic activity in making informed decisions on future returns. Uncertainty in inflation forecasting makes determining the actual future performance of assets difficult.

2.3. The Influence of Interest Rates on Stock Prices and Investment Decisions

Fisher (1930) argued that nominal interest rates fully incorporate information about future inflation and can be expressed as the sum of anticipated actual inflation rates. This concept is also applied to the rate of return on common stocks and other assets. Interest rates are significant to investors and companies, as they are used to invest and increase production capacity. Changes in interest rates affect the company's profitability, which impacts the distribution of dividends to shareholders, which is reflected in the company's stock return (M J Gordon 1959). High interest rates encourage investors to substitute stocks for financial assets, reducing the demand for stocks and leading to a price decline. However, the relationship between interest rates and stock prices is subject to differing perspectives. Some studies indicate a negative correlation between the two (Gordon and Shapiro 1956; Spiro 1990; Mok 1993; Abdullah and Hayworth (1993); and Maysami and Koh 2000; Eldomiaty et al. 2020).

The argument for a negative relationship between interest rates and stock prices is based on the premise that higher interest rates will decrease the value of stocks. Hence, Gordon and Shapiro (1956) argued that fixed-income securities become more attractive to investors than stocks. Mok (1993) presents a similar argument, showing that rising interest rates lower the present value of future dividend income, leading to lower stock prices. Higher interest rates may also reduce investors' willingness to borrow and invest in the capital market. Conversely, some theoretical studies indicate a positive relationship between interest rates and stock prices. Research (Shiller 1988; Asprem 1989; Barsky 1986; Nasseh and Strauss 2000) has shown that stock returns are positively cointegrated with short-term interest rates but negatively cointegrated with long-term interest rates. Mukherjee and Naka (1995) concluded that stock returns are positively cointegrated with short-term call money rates but negatively cointegrated with long-term government bond rates. Humpe and Macmillan (2009) conducted research in the context of the United States and tested that there is a negative effect of long-term interest rates on American stock returns. Andrieș et al. (2014) researched the Indian context and found that interest rates and stock prices are interrelated. Peiro (2015) conducted research in the context of the UK, Germany, and France and concluded that interest rates affect stock returns.

2.4. The Fama–French Five-Factor Model (5FF)

The 5FF model attracts the interest of researchers who focus on asset pricing. The 5FF model includes factors such as market excess return, size (SMB), book-to-market (HML), profitability (RMW), and investment (CMA). Fama and French (2015) found that the 5FF model outperforms the three-factor model in explaining the cross-section of stock returns, as it produces fewer mispricings when accounting for anomalies. However, they concluded that the HML factor becomes redundant when RMW and CMA factors are included. Guo et al. (2017) tested the 5FF model in the Chinese stock market, grouping stocks into portfolios and analyzing returns. The results showed that investment had an insignificant impact on stock returns. Kubota and Takehara (2017) found that beta RMW and beta CMA have an insignificant relationship with Japan's cross-sectional variation in stock returns. Foye (2018) concluded that the 5FF model consistently outperforms the three-factor model in Eastern Europe and Latin America. However, the profitability or weak investment premium effect is indistinguishable from Asian factors, and the 5FF model fails to provide a better description of equity returns in the region. Chiah et al. (2016) investigated the 5FF model in pricing equities in the Australian capital market and compared their results with the empirical results of the capital market in the United States. The findings indicate that the 5FF model is a superior asset pricing model for valuing equities in Australia. Several studies have demonstrated the inconsistent performance of the 5FF model across regions.

2.5. Fama–French Seven-Factor Model (7FF)

A limitation of the 5FF model is its inability to account for the time variation in portfolio returns fully. Some studies show that the performance of the 5FF model could be more consistent. This finding reinforces Fama and French's (2015) view that the factors of the 5FF model are incomplete in explaining stock returns (Chiah et al. 2016). This statement is reinforced by research by Bergbrant and Kelly (2015); Roy and Shijin (2018); Adcock et al. (2022); Eduardo and Gonzalez (2021), and; Bhaskaran and Sukumaran (2021); which shows that, in some cases, the 5FF model has helped predict financial markets. However, investors want to form a more complete model to better estimate the stock market's ability. The weaknesses of the 5FF model encourage further research to create a more comprehensive model that can better predict stock market performance. The 7FF model is then developed by retaining the five original factors from the 5FF model: the market excess return, SMB, HML, RMW, and CMA factors. In addition, two additional factors that reflect macroeconomic conditions, namely, inflation and interest rates, are integrated into the model. Incorporating these variables is intended to improve the weaknesses of the 5FF model and provide a more comprehensive picture of the factors affecting stock returns, allowing for more accurate predictions of stock market performance.

After reviewing various key studies related to property and real estate stocks, including their vulnerability to macroeconomic risks such as interest rates and inflation, this study closes an important gap by integrating Fisher's theory into the Fama–French model. In addition, this study extends the Fama–French five-factor model (5FF) into a more comprehensive Fama–French seven-factor model (7FF) by incorporating inflation and interest rates, two factors that have often been overlooked by previous studies, especially in developing countries such as Indonesia. These additions make an important contribution to understanding the relationship between macroeconomic variables and stock returns in the property and real estate sector, particularly in Indonesia, which has rarely been studied before. As such, this study offers new insights for investors and policymakers in evaluating risks and returns in the sector and fills a gap in the literature regarding the impact of macroeconomic factors on property and real estate stocks.

3. Data and Research Methods

3.1. Data

This study uses monthly data on property and real estate stocks, which include closing stock price data, the number of shares outstanding, the composite stock price index, the book value of equity, the risk-free rate, the operating income, the interest expense, total assets in year t-2 and t-1, inflation, and interest rates. The sample period is from July 2018 to June 2023. The selection of this sample period is based on Bank Indonesia's monetary policy changes, such as interest rate hikes, which put pressure on the property sector. This allows testing the Fama–French five-factor model (5FF) and the Fama–French seven-factor model (7FF) in a dynamic economic context. The five-year span provides sufficient data for reliable statistical analysis and is consistent with Fama and French's (2015) research, so this period is representative of testing the effect of inflation and interest rates on property and real estate stock returns. The research sample does not include financial firms, as these firms have a higher level of leverage compared to non-financial firms. High leverage in financial firms is a characteristic of their economic function, which may not have the same meaning as in non-financial firms, where high leverage more often indicates financial stress (Fama and French 2015). All stocks with negative book equity value are also eliminated from the sample. In addition, stocks must have data on operating profit, interest expense, and the book value of equity in the previous year (t-1). The data were obtained from the Indonesia Stock Exchange (www.idx.go.id, accessed on 2 February 2024). The number of samples is 92 stocks. The risk-free rate uses government bond yields, namely, Government Securities (SBN) (data obtained from the Ministry of Finance website)- https://www.djppr.kemenkeu.go.id/datahistoristingkatkuponsbrdantingkatimbalanst, accessed on 2 February 2024). Inflation and interest rate data were obtained from Bank Indonesia (www.bi.go.id. accessed on 2 February 2024).

3.2. Research Methods

3.2.1. Research Model

This research uses and compares two asset pricing models in estimating property and real estate stock returns, as follows:

Fama–French five-factor model (5 FF).

$$R_{it} - R_{Ft} = a_i + bi(R_{Mt} - R_{Ft}) + {}_{si}SMB_t + {}_{hi}HML_t + {}_{ri}RMW_t + {}_{ci}CMA_t + e_{it} \quad (1)$$

Fama–French seven-factor model (7FF).

$$R_{it} - R_{Ft} = a_i + b_i(R_{Mt} - R_{Ft}) + {}_{si}SMB_t + {}_{hi}HML_t + {}_{ri}RMW_t + {}_{ci}CMA_t + {}_{in}Infla_t + {}_{sb}SB_t + e_{it.} \quad (2)$$

The 7FF model builds on the 5FF model by incorporating inflation (infla) and interest rates (SB).

3.2.2. Portfolio Construction

The 5FF model includes several key factors: the market factor (Rm–Rf), size (small minus big—SMB), book-to-market (high minus low—HML), profitability (robust minus weak—RMW), and investment (conservative minus aggressive—CMA). The sample is independently sorted by market capitalization and book-to-market (B/M). Table 1 illustrates the ranking of stocks by market capitalization. Stocks in the top 50% of the total market capitalization at the end of year $t - 1$ are classified as large stocks (B), while stocks in the bottom 50% are classified as small stocks (S). In addition, stocks are sorted into three value categories based on B/M: High (H), Neutral (N), and Low (L), using the 30th, 40th, and 30th percentiles of the stock's B/M. This sorting resulted in six portfolios based on size and B/M: SH, SN, SL, BH, BN, and BL. The SMB and HML factors are obtained from the two-dimensional (2 × 3) portfolio. HML is calculated as [(SH + BH)/2 − (SL + BL)/2], and the size-BM quantiles are calculated as follows: [(SH + SN + SL)/3 − (BH + BN + BL)/3].

Table 1. The 5FF portfolio formation.

Size	B/M			Profitability			Investment		
	L	M	H	R	M	W	C	M	A
Small (S)	SL	SM	SH	SR	SM	SW	SC	SM	SA
Big (B)	BL	BM	BH	BR	BM	BW	BC	BM	BA

Note: B/M = book-to-market, RMW = robust minus weak, CMA = conservative minus aggressive.

The RMW factor is obtained by ranking the stocks based on profitability. This ranking results in three profitability categories: Robust (R), Neutral (N), and Weak (W). The percentiles used are 30, 40, and 30 of the RMW stocks. The combined size and profitability portfolio consists of SR, SN, SW, BR, BN, and BW. The RMW factor is calculated as [(SR + BR)/2 − (SW + BW)/2] and yields the size-profitability quantile, which is determined as follows: [(SR + SN + SW) /3 − (BR + BN + BW)/3].

Similarly, the CMA factor is calculated by sorting investments into three categories: Conservative (C), Neutral (N), and Aggressive (A), based on the 30th, 40th, and 30th percentiles of investment stocks. A mix of investment measures and portfolios, including SC, SN, SA, BC, BN, and BA. The following formula calculates the CMA factor: [(SC + BC)/2 − (SA + BA)/2], and it results in investment size quantiles, which are determined as follows: [(SC + SN + SA)/3 − (BC + BN + BA)/3]. The double sorting method results in three size factors: BM-size, profitability-size, and investment-size. Following Fama and French (2015), the size factor is calculated as the average of the three factors: [SMB = (size-BM + size-profitability + size-investment)/3].

This study calculates the excess return of 25 B/M-size portfolios, 25 profitability-size portfolios, and 25 investment-size portfolios as the dependent variable. The portfolio excess return is the portfolio return minus the risk-free rate.

This research employs the Ordinary Least Squares (OLS) estimation technique, which enables researchers to identify the best-fitting line that minimizes the error in estimating parameters. The outcomes of the data analysis, including parameter estimates and the resulting optimal line, are provided in detail in Appendices A and B for further review. In addition, Akaike's Information Criterion (AIC) is used to select the best model from the two tested models, with the model with the lowest AIC value identified as the most effective model.

4. Results

The statistical description for each independent variable (asset pricing factor) for July 2018–June 2023 (60 observations) can be seen in Table 2. Panel A shows that the average value of SMB is 2.700, HML (3.383), RMW (1.849), CMA (−1.690), infla (2.852), and SB (4.537). These results show that stocks with small capitalization tend to have higher returns than stocks with large capitalization. High book-to-market values tend to have higher returns (as in the research of Fama and French (1992)).

Table 2. Summary statistics of asset pricing factors and correlations.

Panel A: Summary Statistics of Asset Pricing Factors							
	Rm–Rf	SMB	HML	RMW	CMA	Infla	SB
Mean	−2.613	2.700	3.383	1.848	−1.690	2.852	4.537
Median	−2.789	3.399	3.326	1.323	−1.371	2.800	4.250
Maximum	3.945	5.142	5.295	7.396	−0.724	5.950	6.000
minimum	−8.231	−0.659	2.143	0.338	−3.142	1.330	3.500
Std dev.	3.719	1.691	0.835	1.636	0.735	1.283	0.964
Panel B: Correlations							
	Rm–Rf	SMB	HML	RMW	CMA	Infla	SB
Rm–Rf	1.000	0.030	0.219	0.157	−0.072	−0.001	0.312
SMB	0.030	1.000	0.056	−0.502	−0.061	−0.237	−0.688
HML	0.219	0.056	1.000	0.064	−0.079	−0.420	−0.005
RMW	0.157	−0.502	0.064	1.000	0.222	−0.014	0.470
Infla	−0.001	−0.237	−0.420	−0.014	0.146	1.000	0.365
SB	0.312	−0.688	0.000	0.470	0.330	0.365	1.000

Note: Rm = return market portfolio, Rf = risk-free rate, SMB = small minus big, HML = high minus low, RMW = robust minus weak, CMA = conservative minus aggressive, infla = inflation, SB = interest rate.

The factor standard deviations are 3.719, 1.691, 0.835, 1.636, 0.735, 1.283, and 0.964, respectively, for Rm–Rf, SMB, HML, RMW, CMA, inflate, and SB. The standard deviation provides information on the spread of the data from the mean. The standard deviation of Rm–Rf indicates a high market risk, reflecting more significant uncertainty and risk. SMB and RMW show moderate company size and profitability variability, indicating a good balance between risk and return. HML and CMA have low variability in value and investment. Inflation and interest rates show moderate variability, reflecting a balance of risk and return in inflation and interest rates. High variability indicates high risk, while moderate variability indicates a balance between risk and return.

Table 2 panel B shows the correlation between the various factors. A weak, almost zero correlation exists between the market risk (Rm–Rf) and inflation (0.001). Changes in inflation have virtually no effect on the market risk. The evidence supports Fisher's (1930) theory. The moderate and positive correlation between the market risk (Rm–Rf) and interest rates is 0.312; indicating that when interest rates rise, the market risk also tends to increase, although this relationship could be more robust. The highest correlation between

SMB and interest rates (−0.688) indicates that smaller firms are more affected by rising interest rates than larger firms.

4.1. Fama–French Five-Factor Model (5FF)

4.1.1. Size-BM

In Table 3, size small—low BM with h (0.113)—shows that portfolios in this quantile have less influence on returns than those in higher quantiles. The statistical t(h) values of the first and second quantiles (1.43; 1.766) are less than 2, indicating that the coefficient h is insignificant. The effect of size-BM on returns increases as the BM ratio rises, and statistical significance starts from the third quantile upwards. The high h coefficients (1.561; 2.214; 3.055; 4.323; 5.257) for a large size indicate that large-size portfolios and high BM significantly affect returns. The effect of size-BM is highly significant and increases sharply, indicating that portfolios with a large size and high BM have high returns with vital statistical significance. These results support the research (Jiao and Lilti 2017).

Table 3. Average monthly excess return on portfolio 25 (5FF).

	Low	2	3	4	high		Low	2	3	4	high
		Size-Book to Market									
			h						t(h)		
Small	0.113	0.138	0.284	0.319	0.529	Small	1.430	1.766	2.616	4.367	4.529
2	0.547	0.452	0.682	0.779	1.064	2	2.635	2.671	2.864	3.238	4.532
3	0.148	1.136	1.218	1.33	1.663	3	3.653	3.933	4.161	4.172	5.109
4	1.554	1.75	1.86	2.534	2.956	4	4.321	4.471	4.776	4.345	5.698
Big	1.561	2.214	3.055	4.323	5.257	Big	4.507	4.737	5.267	5.633	6.537
		Size-Profitability									
			r						t(r)		
Small	−0.288	−0.242	−0.165	−0.216	−0.267	Small	−1.657	−1.647	−1.540	−1.631	−1.783
2	−0.487	−0.499	−0.408	−0.559	−0.567	2	−1.835	−1.697	−1.607	−2.123	−2.423
3	−1.767	−0.238	−0.241	−0.389	−0.404	3	−2.554	−1.328	−1.327	−1.893	−1.998
4	−1.022	−0.243	−0.279	−0.321	−0.450	4	−2.096	−1.455	−1.416	−1.713	−2.105
Big	−0.312	−0.154	−0.234	−0.166	−0.399	Big	−1.245	−1.392	−1.374	−1.503	−2.050
		Size-Investment									
			c						t (c)		
Small	3.654	3.546	3.642	3.830	3.877	Small	5.545	5.745	5.819	6.123	6.333
2	3.746	3.823	3.699	3.777	3.856	2	5.765	6.023	5.997	6.003	6.998
3	3.967	3.729	3.818	3.931	4.388	3	5.597	5.935	6.102	6.131	7.245
4	4.273	3.921	4.004	4.235	5.347	4	6.229	6.112	6.511	6.823	7.471
Big	4.707	4.991	5.172	5.345	6.193	Big	6.523	7.021	7.121	7.404	7.891

4.1.2. Size-Profitability

The coefficient (r) (in Table 3) ranges from −0.288 to −0.267, indicating a negative relationship between profitability and small size. T-statistic t(r) ranges from −1.657 to −1.783. All t-values are negative and close to or below −2, indicating a significant negative relationship between profitability and a small size. The smaller the firm size, the lower the level of profitability. This finding is consistent across all quantiles, indicating that profitability is generally negatively related to the firm size. In the study by Fama and French (2015), small stock portfolios with the lowest profitability also have low average returns.

4.1.3. Size-Investment

In the size small category (in Table 3), the coefficient (c) ranges from 3.654 to 3.877, indicating that small-sized companies have a relatively stable and high level of investment. The t-statistic value of 5.545 to 6.333 indicates that the relationship between a small size and an investment is highly significant. The coefficient (c) for sizes 2, 3, and 4 indicates that the t-statistic relationship between size and investment is highly significant. Likewise, at a large size, the value of t(c) ranges from 4.707 to 6.193 and has the highest level of investment. The t-statistic values from 6.523 to 7.891 indicate that the relationship between size and investment is highly significant. The larger the company size, the higher the investment level.

4.2. Fama–French Seven-Factor Model (7FF)

4.2.1. Size-BM

In the size small category (in Table 4), the coefficient (h) ranges from 0.133 to 0.529, indicating that size small stocks have lower BM values. T-statistics range from 1.336 to 4.003, indicating that the relationship between size small and BM is statistically significant, especially at higher BM values. Quantiles 2, 3, and 4 have moderately high t-statistic values. The coefficient (h) on size large quantiles ranges from 3.411 to 6.537, indicating that size large has the highest BM values. T-statistics of 8.423 to 9.767 suggest that the relationship between size large and BM is highly significant. These results align with the research in which Fama and French (2015) identified that company size and BM are essential factors in determining stock returns.

Table 4. Average Monthly Excess Return on Portfolio 25 (7FF).

	Low	2	3	4	high		Low	2	3	4	high
		Size-Book to Market									
			h						t(h)		
Small	0.133	0.188	0.304	0.419	0.529	Small	1.336	2.765	3.662	3.875	4.003
2	0.647	0.782	0.882	0.979	1.064	2	4.123	4.323	4.505	4.699	5.111
3	1.148	1.256	1.408	1.530	1.663	3	5.332	5.423	5.556	5.776	5.981
4	1.854	2.07	2.227	2.634	/13.056	4	6.213	6.899	7.023	7.876	8.231
Big	3.411	3.818	4.189	5.023	6.537	Big	8.423	8.878	8.999	9.234	9.767
		Size-Profitability									
			r						t(r)		
Small	−1.292	−0.702	−0.349	−0.315	−1.021	Small	−2.883	2.047	2.241	−2.121	−2.101
2	−1.487	−0.398	−0.308	−0.659	−1.874	2	−2.430	2.455	2.544	−2.234	−2.005
3	−1.966	−0.307	−0.230	−0.488	−2.231	3	−3.111	2.128	2.227	−2.645	−2.898
4	−2.051	−0.343	−0.268	−0.580	−1.334	4	−3.335	2.335	2.421	−2.731	−1.787
Big	−1.311	−0.438	−0.334	−0.366	−1.102	Big	−2.435	2.692	2.534	−2.376	−1.531
		Size-Investment									
			c						t (c)		
Small	3.854	3.746	3.842	3.977	4.067	Small	5.745	5.915	5.995	6.141	6.367
2	3.846	3.899	3.989	3.988	4.111	2	5.723	5.954	6.138	6.153	7.001
3	4.233	4.336	4.318	4.445	4.588	3	6.150	6.131	6.333	6.445	7.345
4	4.473	4.521	4.689	4.735	5.414	4	6.266	6.289	6.611	6.681	7.576
Big	4.907	4.999	5.243	5.412	6.222	Big	6.856	7.099	7.221	7.678	8.022

Note: h, r, c = coefficients, t(h), t(r), t(c) = t statistics.

4.2.2. Size-Profitability

The coefficient (r) on the small-size (in Table 4) quantile ranges from −1.292 to −1.021, indicating negative profitability for small firms. The t-statistic results range from −2.883 to −2.101, indicating that the relationship between the small size and profitability is negatively statistically significant. All quantiles 2, 3, and 4 show significant negative profitability. In the large-size quantile, the coefficient (r) ranges from −1.311 to −1.102, indicateings that profitability is also negative for large companies. All company sizes show negative profitability. The t-statistic values indicate the significant relationship between the size and negative profitability. Smaller firms tend to experience lower profitability or more significant losses than larger firms, and the trend is statistically significant.

4.2.3. Size-Investment

The coefficient (c) on the size small ranges from 3.854 to 4.067, indicating a relatively high level of investment. The t-statistic of 5.745 to 6.367 indicates that the relationship between the size small and the investment is statistically significant. In quantiles 2, 3, and

4, size-investment shows very high statistical significance. In the big-size quantile, the coefficient (c) values ranges from 4.907 to 6.222, indicating a very high level of investment. T-statistics of 6.856 to 8.022 also show very high statistical significance. The regression results show that the firm size positively correlates with the level of investment; a larger size tends to have a higher investment and is significant (Kubota and Takehara 2017). This finding indicates that large firms allocate more resources to investment than small firms.

4.3. Analysis of OLS Regression Results: Comparing the 5FF and 7FF Models

In Table 5, the intercept for the excess market return (Rm–Rf) has a coefficient of 0.005 and a t-statistic of 1.765, indicating a positive but not statistically significant relationship. The SMB intercept, with a coefficient of 0.007 and a t-statistic of 1.878, also shows a positive relationship but is not statistically significant. The HML intercept reveals a significant positive relationship. The RMW intercept demonstrates a significant positive relationship, with a coefficient of 0.007 and a t-statistic of 2.008, suggesting that companies with high profitability tend to achieve higher returns.

Table 5. Regression results of asset pricing factors.

	Int	Rm–Rf	SMB	HML	RMW	CMA	Infla	Sb	R^2
Rm–Rf									
Coef	0.005		0.068	0.132	−0.062	0.057	0.072	0.068	0.559
t-stat	1.765		1.761	1.892	−1.698	2.057	2.205	1.986	
SMB									
Coef	0.007	0.008		0.531	0.075	0.111	0.069	0.068	0.515
t-stat	1.878	1.789		2.401	1799	2.115	2.343	2.131	
HML									
Coef	0.006	0.055	0.061		0.067	0.058	0.068	0.075	0.485
t-stat	2.151	1.945	1.998		1.897	2.381	2.381	2.334	
RMW									
Coef	0.007	−0.057	0.064	0.066		0.053	0.059	0.067	0.595
t-stat	2.008	−0.691	2.135	2.115		1.982	2.671	2.138	
CMA									
Coef	0.052	0.065	0.072	0.059	−0.072		0.059	0.063	0.521
t-stat	2.111	2.003	2.212	1.728	−1.241		1.835	2.065	
Infla									
Coef	0.063	0.072	0.082	0.063	−0.053	−0.068		0.072	0.487
t-stat	2.101	2.102	2.222	1.959	−1.951	−2.026		1.972	
Sb									
Coef	0.059	0.052	0.169	0.059	−0.061	−0.058	−0.05		0.497
t-stat	2.122	2.053	1.991	2.059	−1.803	−1.926	−1.9		

Note: Rm–Rf = return market-risk free return, SMB = small minus big, HML = high minus low, RMW = robust minus weak, CMA = conservative minus aggressive, infla = inflation, SB = interest rate.

The CMA intercept coefficient of 0.052 and t-statistic of 2.111 indicate that firms adopting conservative investment strategies tend to earn greater returns. The Fama–French five-factor model (5FF) reveals significant positive relationships between most factors and stock returns. The addition of inflation and interest rates in the model maintains the significance of these relationships. In Table 6, the Fama–French seven-factor model (7FF) shows an increased R^2 value (0.535) compared to 5FF (0.527), signifying higher effectiveness in explaining return variability. The superiority of 7FF is also evident from the lower AIC value of −0.053 compared to −0.045 in 5FF.

Table 6. Evaluation of the Fama–French model.

Model	R^2	AIC
Fama–French five-factor model (5FF)	0.527	−0.045
Fama–French seven-factor model (7FF)	0.535	−0.053

5. Discussion

The finding and novelty of this study lie in proving that, although inflation has almost no effect on the market risk of property and real estate stocks (due to a correlation of 0.001), other factors, such as interest rates and company size, have a significant role in determining the return and risk on property and real estate stocks in Indonesia. This study strengthens Fisher's theory by showing that inflation does not directly affect stock returns but reveals that rising interest rates impact small-sized property and real estate companies more. This finding highlights the importance of considering certain macroeconomic variables in the stock risk and return analysis and proving that small companies in this sector exist. However, riskier ones tend to offer higher returns (in line with the results of a study by Fama and French (2015)). Stocks with high book-to-market values tend to have higher returns. Undervalued stocks (with higher a book value than market value) in the property and real estate sectors show more significant return potential.

Some of these findings have important implications for developing property and real estate stocks: first, the potential for higher returns. Property stocks with a high book-to-market value are considered undervalued, meaning the stock's market price is lower than its book value. The market may ignore or undervalue these stocks, thus offering higher return potential. Second, investment opportunities. Investors looking for profitable investment opportunities may consider undervalued property stocks. Property and real estate stocks provide significant value appreciation potential when the market realizes their intrinsic value. Third, investment strategy. Investors focusing on value investing utilize stocks with a high book-to-market value as part of their investment strategy. These stocks often provide better returns in the long run than overvalued stocks. Fourth, improved fundamentals. Undervalued property and real estate companies may have strong fundamentals but must be adequately valued by the market. When the company's fundamentals improve or when there is an improvement in market sentiment, the value of these stocks tends to increase and provide returns to investors. Fifth, risk assessment. Despite offering higher potential returns, undervalued stocks are often associated with certain risks, such as market uncertainty or company-specific issues. Investors should conduct an in-depth analysis to assess whether the stock is truly undervalued and has growth potential.

6. Conclusions

This study is interesting as it finds that property and real estate stocks in Indonesia with negative profitability across all quantiles can hedge against inflation and interest rate pressures. In addition, this study shows that interest rates are not the only factor affecting market risk. The results of this study provide evidence that investment in developing countries such as Indonesia is very attractive to investors because, in addition to its high growth potential, specific sectors can protect against macroeconomic risks.

The influence of macroeconomics (inflation and interest rates) on portfolio returns is tested using the 5FF and 7FF models. Overall, the Fama–French seven-factor model (7FF) explains Indonesia's variability of property and real estate stock portfolio returns better than the 5FF model. The 7FF model provides a more complete understanding of the determinants of stock returns, as indicated by higher R^2 values and lower AIC values. The 7FF model adds two additional factors, inflation and interest rate risk, which allows for a more in-depth analysis of the effect of external variables on stock returns. The results show that the 7FF model is more accurate in explaining portfolio returns and can identify a more complex relationship between stock returns and macroeconomic variables. However, this study has limitations, as it only focuses on the property and real estate sector in Indonesia, so the results may not be generalizable to other sectors. The analysis is also limited to interest rates and inflation, without taking into account other macroeconomic factors such as fiscal policy and exchange rate volatility. In addition, the Fama–French model used cannot capture more complex market dynamics. Future research can expand the scope by testing other sectors, adding macroeconomic variables such as fiscal policy and exchange rate volatility as well as environmental, social, and good governance factors, and using more advanced methods, such as machine learning, to provide a more comprehensive understanding of stock risk and performance.

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Appendix A. OLS Results in the Fama–French Five-Factor Model (5FF)

Table A1. Normality test.

Portfolio	Jarque-Bera	Probability
Size-BM	1.876	0.391
Size-OP	2.341	0.309
Size-INV	2.671	0.263

Table A2. Heteroscedasticity Test.

Portfolio	Breusch–Pagan Test	*p*-Value
Size-BM	3.513	0.622
Size-OP	4.631	0.064
Size-INV	5.254	0.414

Table A3. Multicollinearity test.

Variable	Size-BM	Size-Profitability	Size-Investment
MKT-RF	1.098	1.119	1.068
SMB	1.378	1.278	1.377
HML	1.065	1.075	1.068
RMW	1.491	1.358	1.391
CMA	1.078	1.068	1.128

Table A4. Autocorrelation test.

Portfolio	Lag Autocorrelation	D-W Statistic	*p*-Value
Size-BM	−0.020	1.963	0.644
Size-OP	0.117	1.742	0.294
Size-INV	−0.226	2.742	0.526

Table A5. Variable Bias Test (Ramsey Reset Test).

Portfolio	F-Statistic	Probability
Size-BM	1.234	0.297
Size-OP	0.987	0.325
Size-INV	1.578	0.214

Appendix B. OLS Results in the Fama–French Seven-Factor Model (7FF)

Table A6. Normality test.

Portfolio	Jarque-Bera	Probability
Size-BM	2.345	0.422
Size-OP	2.352	0.512
Size-INV	2.755	0.345

Table A7. Heteroscedasticity test.

Portfolio	Breusch–Pagan Test	*p*-Value
Size-BM	5.087	0.649
Size-OP	5.189	0.637
Size-INV	7.254	0.403

Table A8. Multicollinearity test.

Variable	Size-BM	Size-Profitability	Size-Investment
MKT-RF	1.578	1.578	1.578
SMB	2.567	2.567	2.567
HML	1.214	1.214	1.214
RMW	1.718	1.718	1.718
CMA	1.407	1.407	1.407
Infla	1.843	1.843	1.843
SB	2.526	2.526	2.526

Table A9. Autocorrelation test.

Portfolio	Lag Autocorrelation	D-W Statistic	*p*-Value
Size-BM	−0.317	2.419	0.656
Size-OP	−0.114	2.205	0.892
Size-INV	−0.426	2.774	0.182

Table A10. Variable Bias Test (Ramsey Reset Test).

Portfolio	F-Statistic	Probability
Size-BM	1.355	0.297
Size-OP	1.987	0.325
Size-INV	2.135	0.214

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