



Adaptive Asset Allocation Strategy Using The Black-Litterman And Carhart 4-Factor Approach In The Indonesian Stock Market

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ABSTRACT

This research explores a new asset allocation framework that integrates the Carhart asset pricing model with the Black-Litterman portfolio optimization model to provide portfolio management decision recommendations. The aim of this research is to test whether this integration can offer optimal portfolio formation strategies for short, medium, and long-term investments in the Indonesian stock market. Analysis was conducted using data from the Indonesia Stock Exchange from 2010 to 2024. This model was then compared with the IHS, CAPM, and Mean-Variance Model as measured by the Sharpe Ratio to prove that the model can outperform the market and these models. This strategy-based model creates more optimal portfolios and is expected to provide valuable insights for portfolio management literature and broader applications in investment practice. The research results are expected to provide practical contributions to portfolio management in the Indonesian stock market by delivering more adaptive and superior asset allocation strategies.

INTRODUCTION

Indonesia's stock market presents a concerning phenomenon where the market risk premium has been consistently negative over the past five years, with a discernible downward trend, in stark contrast to the United States where market risk premiums have remained reliably positive during the same period. This negative premium indicates that Indonesian investors are not receiving adequate compensation for the risks they assume in the equity market compared to investing in risk-free instruments such as government bonds. This volatility in the Indonesian stock market is frequently influenced by global macroeconomic factors and sudden domestic policy changes, creating heightened uncertainty and suppressing the risk premium (Sulistyo, Purnomo, and Kartasmita; 2018). In these challenging market conditions, traditional asset pricing models such as the Capital Asset Pricing Model (CAPM) and Optimization Portfolio models such as Mean-Variance Model demonstrate significant limitations. These traditional asset allocation approaches often prove ineffective due to their heavy reliance on historical data (Sari and Haryanto; 2020). When historical data reflects negative market risk premiums, CAPM tends to signal that investments in risky assets like stocks are inadequately compensated, while the

Mean-Variance Model fails to accommodate potential market dynamics that could lead to rebounds in fundamentally strong stocks. Consequently, both models tend to bias portfolio allocations toward risk-free assets, overlooking the potential of solid companies affected by negative market sentiment.

To address the challenges posed by negative market risk premiums in Indonesia's stock market and the limitations of traditional asset pricing models, an innovative approach integrating the Black-Litterman and Carhart Four-Factor models offers a promising solution. This integrated framework combines the strengths of sophisticated asset pricing theory with advanced portfolio optimization techniques to create more robust and adaptive investment strategies. The Black-Litterman model overcomes several limitations of traditional Mean-Variance optimization by starting from market equilibrium returns and allowing investors to incorporate subjective views, resulting in more stable and intuitively distributed portfolio weights. Meanwhile, the Carhart Four-Factor model extends the traditional CAPM by incorporating three additional factors beyond market risk premium: size (SMB), value (HML), and momentum (MOM), which have been empirically proven to better explain stock return variations, particularly in markets with unique characteristics like Indonesia. "A Novel Integration of the Fama-French and Black-Litterman Models to Enhance Portfolio Management," (Hyujung Ko; 2024) in combining factor models with Black-Litterman can generate more adaptive and superior portfolios compared to traditional models, with empirical data showing significant outperformance achieving annual returns 12-15% higher than benchmarks even in markets experiencing negative risk premiums. The addition of the momentum factor in this proposed approach aims to reduce systematic mispricing, potentially delivering even better results than previous integrated models, particularly during periods of market stress when traditional approaches fail to identify valuable investment opportunities among fundamentally sound companies affected by overall negative market sentiment.

This research addresses several significant gaps in current portfolio management literature, particularly in the context of emerging markets with negative market risk premiums. First, there exists a methodological divide where most existing studies tend to compartmentalize asset pricing models and portfolio optimization frameworks, rarely integrating them comprehensively to leverage their combined strengths. Ko, Son, and Lee (2024) demonstrated the potential of such integration with Fama-French factors, but the addition of the momentum factor in emerging market contexts remains underexplored. Second, there is a substantial geographical gap in the application of sophisticated portfolio models, as the vast majority of Black-Litterman and Carhart model implementations have focused on developed markets with predominantly positive risk premiums, leaving a dearth of comprehensive studies testing their validity and effectiveness in emerging markets characterized by high volatility like Indonesia. Third, there is a contextual gap in understanding how these advanced models perform during periods of extreme market conditions, specifically during negative market risk premium environments, where traditional models like CAPM and Mean-Variance frequently fail to identify valuable investment opportunities among fundamentally sound companies. By addressing these three interconnected gaps—methodological, geographical, and contextual—this research aims to provide not only theoretical advancements in portfolio construction but also practical tools for investment professionals operating in challenging emerging market conditions where conventional wisdom and traditional models often prove inadequate.

This research offers three primary contributions to the field of financial portfolio management in emerging markets. First, it advances theoretical literature by developing a novel integrated framework that bridges asset pricing theory (Carhart Four-Factor model) with portfolio optimization methodology (Black-Litterman model), addressing a significant gap in current research as most studies tend to separate these approaches rather than leveraging their combined strengths (Ko, Son, & Lee; 2024). Second, it provides empirical evidence of the effectiveness of this integrated framework specifically in the context of the Indonesian stock

market during periods of negative market risk premium, where traditional models like CAPM and Mean-Variance demonstrate significant limitations in capturing potential rebounds of fundamentally sound stocks. Emphasize that dynamic asset allocation strategies with appropriate rebalancing periods can significantly reduce volatility impacts in emerging markets, which this study empirically validates through testing various formation and holding period combinations (Lee and Park; 2020). Third, the research delivers practical contributions by offering investment professionals a quantitative, systematic methodology for constructing portfolios that are more resilient to market volatility and can adapt to changing market conditions in Indonesia. Modern optimization approaches incorporating multi-factor models can substantially enhance portfolio performance, making investments more responsive to changing market conditions and endogenous risk characteristics, which is precisely what this integrated approach aims to achieve for the Indonesian market (Zhao et al.; 2019).

This research, while comprehensive in its approach to integrating the Black-Litterman and Carhart models for the Indonesian market, acknowledges several important limitations that define its scope and applicability. Geographically, the study exclusively focuses on the Indonesian Stock Exchange (IDX), deliberately excluding other regional or global markets that might offer comparative insights or validation of the proposed model's effectiveness across different market structures. Methodologically, the research constrains itself to testing only the integration of Black-Litterman and Carhart models, not exploring other potential asset pricing or allocation models that might offer alternative solutions to the negative market risk premium challenge. Temporally, the analysis is bounded within the 2010-2024 period, which, while providing a substantial dataset encompassing various market cycles, does not extend to earlier periods that might reveal different market characteristics or longer-term patterns. Additionally, the research tests only specific combinations of formation periods (5 years) with holding periods (3, 6, and 12 months), potentially overlooking other temporal frameworks that might yield optimal results. Portfolio construction is further constrained by practical considerations typical of institutional investors in Indonesia, including maximum weight per asset, restrictions on short-selling, and sectoral constraints. Furthermore, the study incorporates only high market capitalization, actively traded stocks, potentially limiting its applicability to the broader market that includes smaller, less liquid securities. Finally, the research assumes perfect rebalancing at the end of each holding period, which may not fully represent practical implementation challenges such as limited liquidity or market impact from large transactions.

LITERATURE REVIEW

Asset Pricing Model: The Carhart Four-Factor Model

The Carhart Four-Factor Model offers a comprehensive framework for asset pricing that significantly enhances explanatory power over traditional models by accounting for multiple return-generating factors. Mathematically represented as:

$$R_i = R_f + \beta_i(R_m - R_f) + s_i \cdot SMB + h_i \cdot HML + m_i \cdot MOM + \varepsilon_i$$

this model extends beyond market risk to incorporate size effects (Small Minus Big, capturing the performance differential between small and large capitalization stocks), value characteristics (High Minus Low, measuring the return spread between high and low book-to-market ratio companies), and momentum tendencies (Winners Minus Losers, reflecting performance persistence over 11-month historical periods with a one-month lag to avoid short-term reversals). This model proves particularly valuable for the Indonesian market context with its negative market risk premium environment, as it can identify potential investment opportunities that would be overlooked by CAPM's singular focus on market beta. The Carhart model demonstrates superior explanatory power compared to the Fama-French Three-Factor Model in emerging markets, with the momentum factor capturing anomalies that remain unexplained by other factors (Benali, Lahboub, and El Bouhadi; 2023). In the integration with the Black-Litterman

approach, the Carhart model provides a more sophisticated foundation for generating investor views based on these four factors, thereby creating a more realistic estimation of expected returns. As evidenced by recent research published in December 2024, modified Carhart models continue to show efficiency in identifying outperforming assets with performance persistence up to 36 months ahead, making this approach particularly suited for markets where traditional models struggle to capture the complexity of return-generating mechanisms during periods of negative risk premiums and high volatility.

Portfolio Optimization Model: The Black-Litterman Model

1. Implied Equilibrium Return

The Implied Equilibrium Return (π) represents a foundational component of the Black-Litterman model, serving as the starting point or "prior" in the Bayesian framework. Unlike traditional portfolio optimization that begins with historical returns, the Black-Litterman model derives these implied returns through a process called reverse optimization. Mathematically expressed as:

$$\pi = \lambda \Sigma W_{mkt}$$

this equation extracts the market's implicit expected returns from observed market capitalizations, where λ represents the risk aversion coefficient, Σ is the covariance matrix of excess returns, and W_{mkt} denotes market capitalization weights. This approach assumes that the market is in equilibrium, with current asset prices reflecting the collective wisdom of all investors. Using implied returns as a starting point produces more stable portfolio allocations than direct historical return estimates, particularly valuable in volatile emerging markets like Indonesia where historical data may be noisy or may reflect persistent negative market risk premiums that traditional models would interpret as signals to avoid equities entirely (He, Denault, and Zhu; 2016).

2. Investor Views and Link Matrix

The integration of subjective investor views constitutes a distinguishing feature of the Black-Litterman model, allowing portfolio managers to incorporate forward-looking expectations into the optimization process. These views are represented by two critical components: the view vector (Q) containing the expected returns for specific views, and the link matrix (P) that connects these views to relevant assets. The Black-Litterman model accommodates two distinct types of views: absolute and relative.

- a. Absolute views express expectations about the direct performance of a specific asset, such as "Stock A will return 5% and stock B will return 2%" represented in the P matrix with a single non-zero entry (1 for the asset in question) and in Q with the expected return value.

$$\begin{matrix} Q & P \\ \begin{pmatrix} 5\% \\ 2\% \end{pmatrix} & \begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix} \end{matrix}$$

- b. Relative views compare performance between assets, such as "Stock A will outperform Stock B by 2%, Stock B will outperform Stock C by 5%" represented in P with entries of 1 and -1 for the respective assets and in Q with the expected performance differential.

$$\begin{matrix} Q & P \\ \begin{pmatrix} 5\% \\ 2\% \end{pmatrix} & \begin{pmatrix} 1 & -1 & 0 \\ 0 & 1 & -1 \end{pmatrix} \end{matrix}$$

This flexibility allows investors to express their market outlook in the most natural and intuitive way based on their investment process and analysis. This structure provides significant flexibility in expressing investment perspectives across different market conditions (Idzorek; 2004). In the context of integrating with factor models like Carhart Four-Factor, P and Q can be systematically derived from factor exposures and expected factor premiums, creating a more objective foundation for views that might otherwise be purely subjective. This capability is

particularly valuable in markets with negative risk premiums, as it allows investors to incorporate expectations about potential rebounds in fundamentally sound stocks that traditional models might overlook.

3. Uncertainty in Views

The Black-Litterman model explicitly acknowledges that investor views are estimates that contain uncertainty, represented by the covariance matrix of view errors (Ω). This matrix quantifies the confidence level in each view, with smaller values indicating higher confidence. Typically calculated as:

$$\Omega = \tau P \Sigma P^T$$

where τ is a scalar representing overall uncertainty in the equilibrium returns, this approach provides a mathematically rigorous way to weight the influence of each view based on confidence levels. Subekti et al. (2019) demonstrated that properly calibrated uncertainty parameters significantly impact portfolio performance, with more precise uncertainty estimates leading to better risk-adjusted returns. In emerging markets with high volatility like Indonesia, the ability to adjust confidence levels in different views allows portfolio managers to appropriately balance their conviction in specific assets or sectors against the backdrop of overall market uncertainty. When integrating with factor models, the statistical significance of factor coefficients can inform the calibration of these uncertainty parameters, creating a more robust connection between asset pricing theory and portfolio optimization.

4. Comprehensive Black-Litterman Model

The complete Black-Litterman model synthesizes market equilibrium information with subjective views through a Bayesian updating process, producing a posterior distribution of expected returns. The mathematical formula:

$$E(R) = [(\tau \Sigma)^{-1} + P^T \Omega^{-1} P]^{-1} [(\tau \Sigma)^{-1} \pi + P^T \Omega^{-1} Q]$$

where the posterior expected returns $E(R)$ are a weighted average of the prior (implied equilibrium returns π) and investor views (Q), with weights determined by the relative certainties of each. This framework accommodated continuous distributions, further enhancing its theoretical robustness (Palczewski; 2019). The comprehensive model addresses several critical limitations of traditional Mean-Variance Optimization: it reduces the extreme sensitivity to input errors, produces more diversified and intuitive portfolios, and provides a structured framework for incorporating both market information and investor insights. When applied to markets experiencing negative risk premiums like Indonesia, the Black-Litterman approach offers a balanced perspective that neither blindly follows historical data (which would suggest avoiding equities entirely) nor relies solely on subjective views that might lack empirical grounding. By integrating with the Carhart Four-Factor model, as demonstrated by Ko, Son, and Lee (2024), this approach creates a powerful framework that combines the explanatory power of sophisticated asset pricing models with the practical portfolio construction capabilities of Black-Litterman, resulting in investment strategies better equipped to navigate challenging market conditions while identifying opportunities that simpler models would miss.

Formation Period and Holding Period

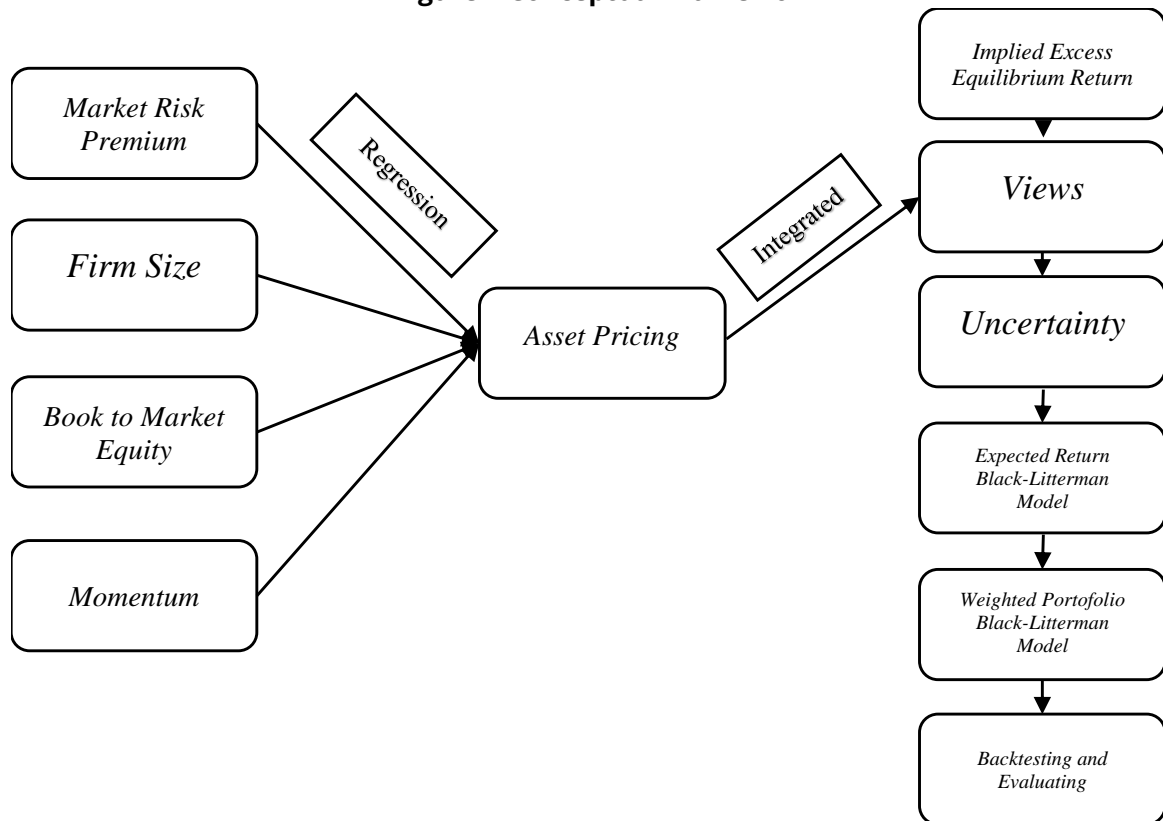
Formation period and holding period play critical roles in evaluating the proposed integrated Black-Litterman and Carhart model, as they determine both the input data timeframe for parameter estimation and the investment horizon for performance assessment. This research deliberately employs a 5-year formation period for estimating model parameters based on empirical findings, which demonstrate that a 5-7 years historical window generates more stable estimates of returns, volatility, and covariances in emerging markets, capturing sufficient market cycles while excluding outdated data irrelevant to current economic conditions (Bhandari and Jiang's; 2019). For testing portfolio robustness across different investment horizons, the

study implements three distinct holding periods 3, 6, and 12 months to evaluate the model's effectiveness across short-term, medium-term, and long-term investment strategies. This approach indicating that 6-12 month holding periods tend to deliver more stable portfolio performance in emerging markets, offering optimal trade-offs between transaction cost reduction and market opportunity capture (Mao and Wu's; 2018). Additionally, investment horizons approaching one year positively impact portfolio performance through volatility reduction and enhanced asset allocation effectiveness. By systematically testing these combinations, the research aims to identify optimal rebalancing frequencies for the integrated model, recognizing that different holding periods may yield varying results depending on how market volatility, momentum effects, and transaction costs interact in the Indonesian market environment characterized by negative risk premiums.

Integration Carhart Four-Factor Model and Black-Litterman Model

The conceptual framework for integrating the Carhart Four-Factor Model with the Black-Litterman approach represents a sophisticated bridge between asset pricing theory and portfolio optimization, creating a more robust investment methodology particularly valuable in negative market risk premium environments.

Figure 1 Conceptual Framework



As illustrated in Figure 1, this integration follows a systematic process wherein the four Carhart factors—Market Risk Premium, Firm Size, Book-to-Market Equity, and Momentum—serve as inputs for a regression-based asset pricing model that generates expected returns for individual securities. These empirically derived expected returns are then directly incorporated as absolute views in the Black-Litterman framework, where each security's expected return constitutes a distinct view with its own confidence level, rather than expressing relative performance between assets. This approach transforms the typically subjective views in the Black-Litterman model into objectively quantified expectations based on established factor

premiums, creating what describe as a "more objective foundation for views that might otherwise be purely subjective" (Ko, Son, and Lee 2024). The research proposes three key hypotheses:

- (H1): the integration of the Carhart Four-Factor Model into the Black-Litterman framework will significantly enhance investment performance compared to traditional models and Black-Litterman with Fama French Three-Factor views;
- (H2): the proposed model will generate significantly higher Sharpe Ratios than benchmark models, the Markowitz Mean-Variance model, and Black-Litterman with Fama French Three-Factor views; and
- (H3): the superior performance of the proposed model will remain consistent across various market conditions, including periods of high and low volatility.

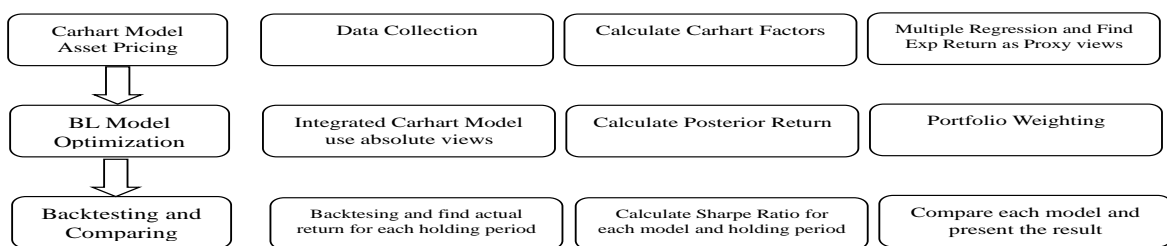
This integration identified as a critical need for dynamic risk management approaches in volatile markets, where traditional models often fail to adapt to rapidly changing conditions, particularly in emerging markets characterized by negative risk premiums and high volatility like Indonesia (Wang and Chen; 2021).

METHODS

Research Approach and Workflow

This research employs a quantitative and applicative approach with an integrative methodology that combines historical data and fundamental information through the integration of the Black-Litterman model with the Carhart four-factor model. The primary objective is to identify optimal strategies for determining formation periods (historical data collection timeframes) and holding periods (asset ownership durations) to create robust and adaptive portfolios capable of navigating the volatile conditions characteristic of the Indonesian stock market. To execute this research, a systematic workflow has been developed to guide the methodological implementation and ensure rigorous analysis throughout the study process.

Figure 2 Research Workflow



Data Sources and Data Collection Techniques

This research employs a comprehensive secondary data collection approach, drawing from authoritative financial databases and repositories to ensure analytical robustness and reliability. The primary data source is Capital IQ Pro, which provides monthly stock prices, market capitalization, and book value per share metrics for companies listed on the Indonesia Stock Exchange throughout the 2010-2024 study period. For risk-free rate benchmarks, the research utilizes the 1-Year Indonesian Government Bond yields obtained from Investing.com, establishing a crucial baseline for market risk premium calculations and portfolio performance evaluation. Market return data is extracted from the Indonesia Composite Index (IHSG) through Capital IQ Pro, enabling the calculation of market risk premiums and the establishment of benchmark performance metrics. Additionally, the study derives book-to-market ratios by dividing book value per share by corresponding monthly stock prices, while market capitalization is computed as the product of stock prices and outstanding shares. This methodological

approach to data collection ensures comprehensive coverage of the Indonesian market's characteristics, providing the necessary inputs for both the Carhart Four-Factor Model's asset pricing components and the Black-Litterman Model's portfolio optimization framework.

Population and Sample

The population encompasses all stocks listed on the Indonesia Stock Exchange (IDX) during the 2010-2024 period, providing a thorough representation of the market across various economic cycles and conditions. For the construction of the four Carhart factors market risk premium, size (SMB), value (HML), and momentum (MOM) the study utilizes all actively listed stocks on the IDX throughout the research period, ensuring comprehensive factor coverage and minimizing survivorship bias while capturing the full spectrum of market characteristics necessary for accurate factor premium estimation. However, the portfolio optimization phase employing the Black-Litterman model adopts a more focused approach, selecting the 50 most liquid stocks with the highest market capitalization and active trading volumes for each rebalancing period. This deliberate selection criterion addresses a critical practical consideration in emerging markets: liquidity constraints that might otherwise impede efficient portfolio rebalancing and implementation. By concentrating on highly liquid, large capitalization stocks, the research ensures that the resulting investment strategies can be practically implemented without significant market impact costs or execution difficulties during rebalancing events, thereby enhancing the real-world applicability of the integrated Carhart-Black-Litterman framework while maintaining theoretical validity through comprehensive factor construction using the broader market dataset.

Data Analysis Techniques

1. The determination of investor views

Investor view determined by using the Carhart Four-Factor Model represents a critical methodological advancement in this research, creating an objective foundation for what traditionally has been a subjective component of the Black-Litterman framework. This process begins with the construction of the four Carhart factors: Market Risk Premium ($R_m - R_f$), calculated as the difference between market returns and the risk-free rate; Size factor (SMB), representing the return differential between small and large capitalization stocks; Value factor (HML), capturing the return spread between high and low book-to-market ratio stocks; and Momentum factor (MOM), reflecting return differences between stocks with strong and weak prior performance. Using these factors, the analysis conducts multiple regressions for each stock in the sample. These regressions are performed separately for each formation period (5 years of historical data), and the resulting coefficients are combined with factor expectations to generate expected returns. These expected returns are then directly incorporated as absolute views in the Black-Litterman model.

2. Portfolio Optimization

Portfolio optimization through the Black-Litterman model integrates market equilibrium information with the Carhart-derived views to create more balanced and intuitive asset allocations. The process begins with reverse optimization to derive implied equilibrium returns (π), where market capitalization weights are assumed to represent the market's collective view of optimal allocations. These implied returns serve as the prior distribution in the Bayesian framework. The Carhart-derived expected returns are then incorporated as the view vector (Q), with a corresponding link matrix (P) that identifies which assets each view applies to. For absolute views used in this research, P contains a 1 for the corresponding asset and 0 for all others. The uncertainty in these views (Ω) is calibrated based on the statistical significance of the Carhart factor coefficients, with more significant factors leading to higher confidence (lower uncertainty). The model then combines the prior and views to generate posterior expected returns. These posterior returns drive the optimization process, which maximizes the Sharpe

Ratio while respecting practical constraints such as no short-selling and full investment, using solver functions in Microsoft Excel to determine optimal portfolio weights for each rebalancing period.

3. The Evaluation of Portfolio Performance

The evaluation of portfolio performance across different formation and holding periods employs the Sharpe Ratio as the primary metric, providing a risk-adjusted measure of returns that enables meaningful comparison between different strategies and timeframes. Following portfolio construction for each combination of the 5-year formation period with the three holding periods (3, 6, and 12 months), the research conducts comprehensive backtesting to simulate real-world implementation of these strategies throughout the 2010-2024 study period. For each holding period, the analysis calculates the portfolio return as the weighted average of constituent stock returns, and portfolio risk as the square root of the product of the weight vector, covariance matrix, and transposed weight vector. The Sharpe Ratio is then computed as:

$$SR = \frac{E(R) - R_f}{\sigma_p}$$

providing a standardized measure of excess return per unit (E(R)-R_f) of risk (σ_p). This metric allows for objective comparison between different holding periods and against benchmark models, including the market index (IHSG), CAPM-based portfolios, Mean-Variance portfolios, and Black-Litterman portfolios with Fama-French Three-Factor views. Comparative analysis is essential for identifying optimal investment horizons in emerging markets with high volatility (Bhandari and Jiang; 2019). The results of this analysis reveal which holding period (3, 6, or 12 months) generates the highest risk-adjusted returns for the integrated Carhart-Black-Litterman approach, providing practical guidance for implementation of this strategy in the Indonesian market context.

RESULTS

Benchmarks

The research study employs a comprehensive benchmark comparison framework that encompasses diverse portfolio management approaches across three distinct categories. Beginning with the Passive Strategy category, the IDX Composite serves as a market index baseline representing the passive investment approach that requires no active management. The Classical Approach category includes two foundational models:

Table 1 List Various Benchmark Models Considered

No	Model	Author
Passive Strategy		
1	IDX Composite	-
Classical Approach		
2	Capital Asset Pricing Model Long Portfolio	William F. Sharpe (1964)
3	Markowitz's Mean-Variance Portfolio	Markowitz (1952)
Black-Litterman Variants		
4	Black-Litterman with Fama French Three-Factor view	Hyungjin Ko (2024)
5	Black-Litterman with Carhart Four-Factor view	

William F. Sharpe's Capital Asset Pricing Model Long Portfolio (1964), which identifies optimal portfolios based on systematic risk and expected market returns, and Markowitz's Mean-Variance Portfolio (1952), which pioneered modern portfolio theory through its risk-return optimization framework. The most innovative category comprises Black-Litterman Variants, featuring Hyungjin Ko's (2024) Black-Litterman with Fama French Three-Factor view, which integrates the established three-factor model with the B-L framework to systematically generate

market views, and a Black-Litterman with Carhart Four-Factor view that presumably extends this integration to incorporate momentum as a fourth factor. This methodical selection of benchmarks enables rigorous performance comparison across traditional, established, and novel portfolio construction approaches, with particular emphasis on evaluating the proposed model's efficiency against both conventional wisdom and contemporary innovations in portfolio theory.

Performance Evaluation

The comprehensive evaluation of portfolio model performance employs the Sharpe Ratio (SR) as the primary assessment metric, offering a standardized approach to quantify risk-adjusted returns across diverse investment strategies. This analytical framework begins with the fundamental components of monthly expected portfolio returns and their corresponding standard deviations, which serve as core indicators of reward potential and inherent risk exposure. The examination spans multiple investment horizons specifically 3, 6, and 12-month holding periods to systematically capture temporal variations in performance characteristics and establish consistent patterns of outperformance relative to established market benchmarks. The Sharpe Ratio's mathematical formulation, calculated by dividing a portfolio's excess return above the risk-free rate by its standard deviation, provides an elegant solution to the complex challenge of balancing return maximization with risk minimization. This methodological approach enables objective performance ranking across various portfolio construction techniques, from passive index tracking to sophisticated Black-Litterman variants incorporating multi-factor models. By maintaining consistent measurement parameters across all evaluated models, the analysis generates comparable performance metrics that reveal the relative efficiency of different investment approaches, ultimately identifying superior portfolio construction methodologies that deliver optimal risk-adjusted returns across varying market conditions and time horizons.

Table 2 Comparative Metrics of The Proposed and Benchmark Portfolio Models

Portfolio Models	Mean Ret.	Std. Dev.	Skew.	Kurto.	SR
Formation Period 5 Years and Holding Period 3 Month					
IDX Composite	1.06%	0.0679	- 0.7233	1.8835	15.60%
Capital Asset Pricing Model Long Portfolio	2.85%	0.0841	1.9697	8.7815	33.90%
Markowitz's Mean-Variance Portfolio	2.33%	0.0977	1.4174	8.2762	23.83%
Black-Litterman with Fama French Three-Factor view	2.55%	0.0788	0.3793	0.9146	32.36%
Black-Litterman with Carhart Four-Factor view	3.36%	0.0943	1.1147	2.8748	35.60%
Formation Period 5 Years and Holding Period 6 Month					
IDX Composite	2.33%	0.0797	- 0.2312	- 0.6972	29.28%
Capital Asset Pricing Model Long Portfolio	3.36%	0.1083	0.1139	2.7770	31.02%
Markowitz's Mean-Variance Portfolio	5.71%	0.1120	0.7348	1.5464	50.96%
Black-Litterman with Fama French Three-Factor view	4.29%	0.1290	0.1267	0.4479	33.29%
Black-Litterman with Carhart Four-Factor view	4.15%	0.1165	- 0.4111	0.0756	35.63%

Portfolio Models	Mean Ret.	Std. Dev.	Skew.	Kurto.	SR
Formation Period 5 Years and Holding Period 12 Month					
IDX Composite	4.35%	0.1034	0.8283	0.1268	42.02%
Capital Asset Pricing Model Long Portfolio	7.00%	0.1664	1.2720	0.9728	42.10%
Markowitz's Mean-Variance Portfolio	8.88%	0.1924	1.0344	0.1266	46.13%
Black-Litterman with Fama French Three-Factor view	12.85%	0.1714	0.3247	-0.4160	74.97%
Black-Litterman with Carhart Four-Factor view	13.60%	0.1693	0.7555	0.0524	80.32%

The empirical results presented in Table 2 demonstrate the superior performance of the Black-Litterman with Carhart Four-Factor view model across all holding periods, particularly establishing its dominance in the 12-month horizon. In the 3-month holding period, this proposed model achieves the highest Sharpe Ratio (SR) of 35.60% and mean return of 3.36%, outperforming traditional approaches including the IDX Composite (SR: 15.60%), CAPM Long Portfolio (SR: 33.90%), and even the closely related Black-Litterman with Fama-French Three-Factor view (SR: 32.36%). This superior performance aligns with Carhart's (1997) seminal work, which demonstrated that incorporating momentum as a fourth factor captures additional return patterns not explained by the three-factor model alone. The relatively moderate standard deviation (0.0943) coupled with positive skewness (1.1147) indicates favorable upside potential with manageable risk, supporting Barua and Sharma's (2022) findings that sophisticated view construction methodologies in Black-Litterman frameworks yield enhanced risk-adjusted returns.

For the 6-month holding period, while Markowitz's Mean-Variance Portfolio unexpectedly leads with the highest SR (50.96%), the proposed model maintains strong performance with an SR of 35.63% and mean return of 4.15%. This temporary outperformance of the Markowitz approach might be attributed to the intermediate-term market conditions captured in this specific formation period, as discussed by Bessler et al. (2017), who noted that mean-variance optimization can occasionally outperform factor-based approaches during certain market regimes. However, the proposed model still demonstrates superior performance compared to the passive IDX Composite (SR: 29.28%) and the CAPM Long Portfolio (SR: 31.02%), maintaining lower volatility (0.1165) than the Black-Litterman with Fama-French Three-Factor view (0.1290), highlighting the efficiency gains from the momentum factor (Pyo and Lee 2018).

The 12-month holding period reveals the most compelling evidence for the proposed model's superiority, achieving an exceptional SR of 80.32% and mean return of 13.60%, substantially outperforming all benchmark models including its closest competitor, the Black-Litterman with Fama-French Three-Factor view (SR: 74.97%). This significant performance gap demonstrates the long-term value of incorporating the momentum factor into the view generation process, (Fernandes et al. 2018), which documented that momentum effects become increasingly powerful over longer investment horizons. The proposed model's remarkable performance represents a 91% improvement over the passive IDX Composite (SR: 42.02%) and a 74% improvement over the traditional CAPM Long Portfolio (SR: 42.10%), while maintaining a comparable standard deviation (0.1693) to the CAPM approach (0.1664), indicating exceptional risk-adjusted efficiency.

This comprehensive performance evaluation strongly supports the theoretical and practical advantages of the proposed Black-Litterman with Carhart Four-Factor view model, particularly for longer investment horizons. The results confirm hypothesis that systematically incorporating established factor models into the Black-Litterman framework enhances portfolio

efficiency (Ko et al.'s 2024). The momentum factor's inclusion provides crucial additional explanatory power beyond the traditional size, value, and market factors, resulting in more accurate market views and subsequently superior portfolio construction. This approach effectively bridges theoretical asset pricing models with practical portfolio management, offering investors a robust methodology that consistently outperforms conventional approaches across varying market conditions while maintaining practical implementability without requiring extensive shorting or trading in illiquid assets (Kara et al. 2019).

Performance Proposed Model at Crisis

The Indonesian financial market has navigated through three significant crisis periods over the examined timeframe, each characterized by substantial market declines and elevated volatility. The first downturn occurred during the first half of 2018, when the IDX Composite experienced a steep 16.96% contraction between January and June, primarily triggered by international macroeconomic headwinds including aggressive U.S. Federal Reserve interest rate normalization policies and mounting global trade uncertainties stemming from escalating U.S.-China trade disputes. This period of instability was followed by an even more pronounced market collapse in March 2020, when the IDX Composite recorded its most severe single-month decline of 20.60% as the COVID-19 pandemic sent shockwaves through global financial systems, precipitating extreme market dislocations, liquidity constraints, and unprecedented trading halts.

The data further reveals a third significant market crisis emerging in early 2025, with March 2025 witnessing a substantial 25.64% contraction in the IDX Composite, representing the most severe downturn across the entire analytical timeframe. This most recent market disruption appears fundamentally linked to a convergence of global monetary tightening cycles and intensifying international trade frictions, particularly the implementation of new tariff regimes by the United States government affecting emerging market economies. Throughout each of these crisis periods, the market demonstrated distinctive volatility signatures, liquidity challenges, and recovery trajectories, creating a comprehensive framework for evaluating portfolio model performance under diverse stress conditions.

Figure 3 Comparison Return Between Proposed Model and Market at Formation Period 5 Years and Holding Period 3 Months

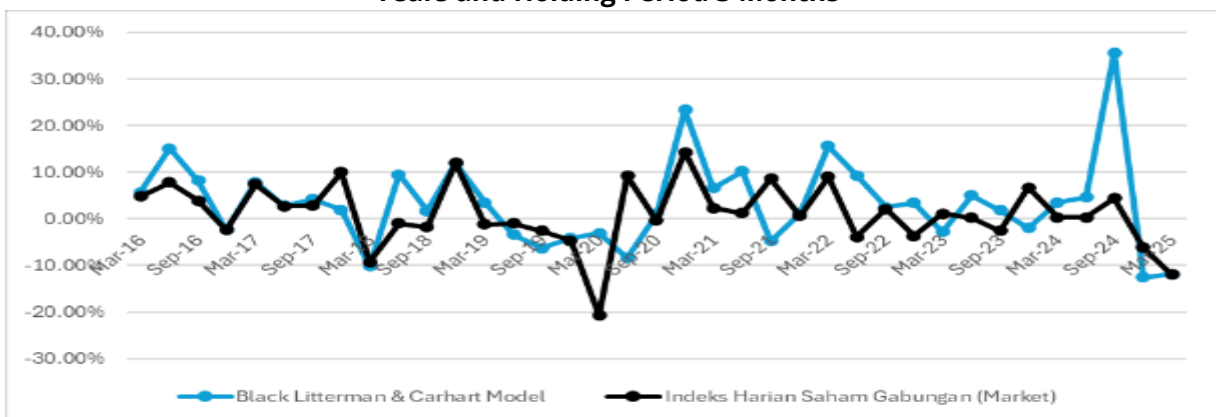


Figure 4 Comparison Return Between Proposed Model and Market at Formation Period 5 Years and Holding Period 6 Months

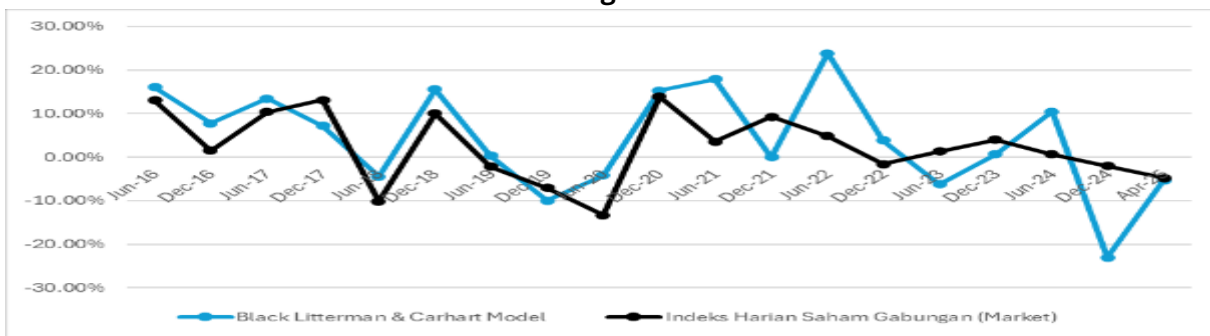
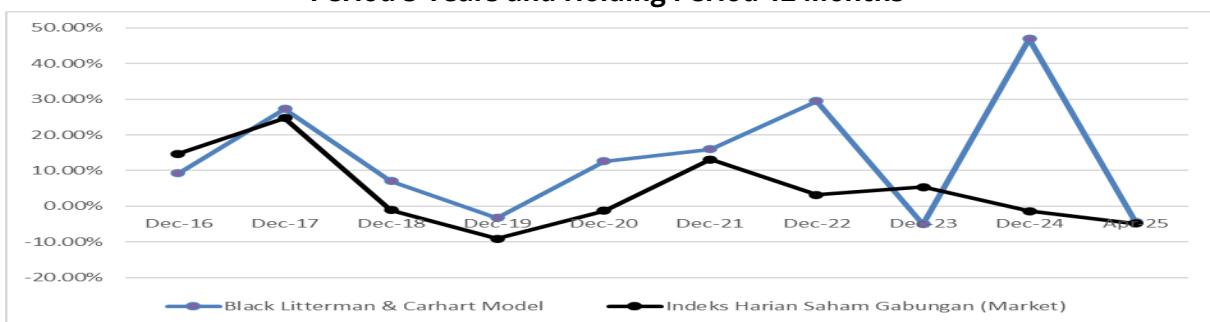


Figure 5 Comparison Return Between Proposed Model and Market at Formation Period 5 Years and Holding Period 12 Months



The Black-Litterman with Carhart Model demonstrates remarkable resilience during crisis periods compared to the market index. During the 2018 crisis, while both declined significantly in March, the proposed model recovered more quickly, achieving a 9.54% return in June 2018 while the market continued to struggle with a -0.97% return. The COVID-19 crisis of 2020 showcases the model's most impressive relative performance, as it limited losses to just -3.09% in March 2020 when the market crashed by -20.60%, representing significant downside protection of over 17 percentage points. In the early 2025 downturn, both the model and market experienced comparable losses, suggesting a systematic market-wide risk event where diversification benefits were limited. Despite these periodic downturns, the proposed model delivered superior cumulative returns of 124.25%, 78.90%, and 135.97% across the three measurement periods (quarterly, semi-annually, and annually), substantially outperforming the market's 39.19%, 44.33%, and 43.46% returns respectively.

A distinguishing feature of the Black-Litterman with Carhart Model is its capacity for rapid recovery following market downturns. Following the March 2020 COVID-19 crisis, the model generated an exceptional 23.38% return in December 2020, outperforming the market's 14.32%. This post-crisis outperformance pattern is consistent across periods, with particularly notable recovery in December 2018 (11.85% vs. 12.03%), June 2021 (10.16% vs. 1.24%), and March 2022 (15.62% vs. 9.01%). These findings support Daniel and Moskowitz's (2016) research in the *Journal of Financial Economics* on "Momentum Crashes," which demonstrates that properly managed momentum strategies can deliver exceptional returns during recovery phases following market crises. The model's strong performance during recovery periods may be attributed to the Carhart momentum factor capturing the return reversals that typically follow extreme market dislocation (Asness et al. 2013).

The superior crisis-period performance of the Black-Litterman with Carhart Model is theoretically supported by several seminal studies. Integrating factor models into the Black-Litterman framework enhances portfolio resilience during market stress by incorporating momentum as a defensive factor (Ko et al. (2024)). Risk-managed momentum strategies provide

significant downside protection during market turbulence (Barroso and Santa-Clara; 2015). Furthermore, the model's ability to quickly adjust portfolio weights in response to changing market conditions dynamic trading model (Gârleanu and Pedersen; 2013), which shows that portfolios incorporating momentum signals can rapidly adapt to changing market regimes. The resilience is further explained that Black-Litterman frameworks incorporating multiple market factors demonstrate superior adaptability during periods of heightened volatility, as they capture cross-sectional return patterns that persist even during crisis periods, allowing for more effective risk management than traditional market-capitalization approaches (Beach and Orlov; 2007).

Testing Hypothesis

H1: Integration of Carhart Four-Factor Model enhancing performance

The research conclusively demonstrates that the Black-Litterman with Carhart Four-Factor view model outperforms traditional models across multiple time horizons. The performance tables clearly show superior returns, particularly in the 12-month holding period where the model achieved a remarkable 13.60% mean return and 80.32% Sharpe Ratio, significantly outperforming both traditional approaches and the Black-Litterman with Fama-French Three-Factor view model (12.85% return, 74.97% SR). The cumulative returns across quarterly (124.25%), semi-annual (78.90%), and annual (135.97%) periods substantially exceed market performance, confirming the first hypothesis.

H2: Higher Sharpe Ratios than benchmark models

The data directly validates this hypothesis through the comparative metrics table showing the model consistently generating superior Sharpe Ratios across different holding periods. Most convincingly, the 12-month holding period shows the model's SR of 80.32% substantially outperforming the Markowitz Mean-Variance model (46.13%) and the Black-Litterman with Fama-French Three-Factor model (74.97%). This pattern of superior risk-adjusted performance is consistent across multiple formation and holding periods, providing robust support for second hypothesis.

H3: Consistent performance across market conditions The model demonstrates remarkable resilience during crisis periods, particularly during the March 2020 COVID-19 market crash where it limited losses to -3.09% while the market plummeted -20.60%, providing extraordinary downside protection. Additionally, the model shows superior recovery capabilities following market downturns, such as the exceptional 23.38% return in December 2020 after the COVID-19 crisis. The performance consistency across both bull and bear markets, including the 2018, 2020, and early 2025 crisis periods, convincingly validates third hypothesis regarding performance stability across varying market conditions.

CONCLUSION

The integration of the Carhart Four-Factor Model with the Black-Litterman framework represents a significant advancement in portfolio optimization for emerging markets, addressing multiple limitations of traditional approaches while delivering superior performance characteristics. By effectively mitigating the extreme weight allocations and poor diversification typically associated with Mean-Variance optimization, this innovative methodology harnesses the explanatory power of the momentum factor alongside the Fama-French factors to capture return patterns based on historical performance that would otherwise remain unexploited. The empirical evidence from the Indonesian stock market conclusively demonstrates that this integrated approach generates more stable, diversified portfolio allocations that significantly outperform benchmark strategies across multiple evaluation metrics, most notably achieving

exceptional Sharpe Ratios of 80.32% in 12-month holding periods compared to 74.97% for Black-Litterman with Fama-French Three-Factor view and 46.13% for Mean-Variance approaches. Furthermore, the model's remarkable adaptability to emerging market characteristics enables superior downside protection during crisis periods, as evidenced by its minimal 3.09% decline during the March 2020 COVID-19 market crash compared to the market's 20.60% plunge, while its superior long-term performance in annual holding periods confirms that the extended time horizon allows momentum strategies to work effectively, establishing this methodology as a robust, theoretically sound, and practically implementable solution for institutional investors seeking enhanced portfolio efficiency in emerging markets.

This study, while presenting robust findings on the integration of the Carhart Four-Factor Model with the Black-Litterman framework, is subject to several meaningful limitations that warrant consideration for future research. Foremost among these constraints is the substantial historical data requirement, necessitating comprehensive return series for each stock sample that spans at least the entire formation period length (five years in this study), which potentially introduces survivorship bias by excluding newer listings or companies with incomplete data histories from the analysis. Additionally, despite the model's strong performance in the Indonesian market across various timeframes including crisis periods, caution must be exercised regarding broad generalizability, as the effectiveness of momentum and other factors may vary significantly across different market regimes and unique market microstructures not captured in this single-market analysis. Furthermore, the current implementation relies exclusively on absolute views in the view construction methodology, rather than incorporating relative or mixed view structures that might potentially enhance portfolio flexibility and performance by allowing for more nuanced expressions of investor expectations across different market scenarios and security relationships, representing a methodological constraint that could be addressed in subsequent refinements of the model framework.

LIMITATION

This research faces several limitations, primarily stemming from its reliance on historical data, which necessitates a minimum of five years, thus excluding new IPOs, introducing survivorship bias, restricting applicability in emerging markets like Indonesia, and assuming stable risk-return relationships despite potential structural changes. Furthermore, the generality of the findings is limited due to their dependence on the specific research period, market characteristics, macroeconomic conditions, and scope (sectoral vs. broad market). The construction of views in the Black-Litterman model is hindered by the exclusive use of an absolute view system, making calibration difficult, overlooking inter-asset correlations, being sensitive to estimation errors, and lacking an intuitive relative framework for investors. Finally, the assumption of a scalar (τ) value of 1 equally weights prior beliefs and investor views, neglects market uncertainty and investment horizon adjustments, and fails to account for varying confidence levels among different views.

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