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Short-Term Portfolio Optimization for Retail Investors in Iran Based on Real-Time Market Volatility and Liquidity Patterns

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Abstract

Short-term portfolio management has become a central concern for retail investors in emerging markets, where volatility spikes and liquidity fluctuations can significantly influence investment outcomes. In Iran's fast-evolving financial environment, short-term decision-making is shaped by rapid information flows, structural liquidity constraints, elevated market uncertainty, and heterogeneous investor behaviour. Despite the increasing involvement of retail participants in the Iranian capital market, limited academic work has examined how real-time volatility and liquidity patterns can be systematically incorporated into short-term portfolio optimization models tailored to their specific constraints. This study develops an integrated analytical framework that combines high-frequency volatility estimation, liquidity-adjusted return measures, and behavioural considerations to enhance short-term portfolio allocation for retail investors. Using real-time market microstructure data—including intraday price variance, bid–ask spreads, turnover velocity, and depth-of-market indicators—the research constructs a multi-stage optimization model that incorporates volatility-sensitive asset weights and liquidity-penalized return functions. The framework further evaluates the sensitivity of optimized portfolios to liquidity shocks, volatility clustering, and sudden price jumps commonly observed in emerging markets. Through empirical evaluation using Iran's equity and fixed-income short-term instruments, the study demonstrates that portfolios incorporating liquidity-adjusted risk metrics outperform traditional variance-based models, particularly during periods of heightened uncertainty. The findings also reveal that retail investors' allocation decisions can be substantially improved when real-time liquidity conditions and short-horizon volatility estimators are integrated into the optimization process. The contribution of this research is threefold: first, it offers a practical and data-driven short-term optimization model calibrated specifically for retail investors in Iran; second, it empirically highlights the importance of liquidity constraints and volatility dynamics in shaping short-term portfolio performance; and third, it provides a foundation for constructing adaptive allocation rules that reflect live market conditions. These insights hold implications for investor education, financial advisory practices, and the design of accessible portfolio optimization tools within emerging markets.

Keywords: Short-term portfolio optimization, Retail investors, Real-time volatility, Market liquidity, Emerging markets.

Introduction

Short-term investment strategies have attracted growing attention among retail investors in emerging markets, particularly as financial systems undergo rapid structural and technological transformation. In Iran, the expansion of digital trading platforms, the increasing participation of first-time investors, and the heightened sensitivity of market dynamics to information flows have reshaped the environment in which individuals make short-horizon financial decisions. These developments have altered the traditional relationship between risk, return, and liquidity, making short-term portfolio management more complex while simultaneously creating new opportunities for informed optimization. As retail investors increasingly rely on fast-moving market signals, their exposure to volatility and liquidity fluctuations has become more pronounced, requiring analytical tools that can translate real-time market conditions into robust allocation strategies.

Volatility has long been recognized as a defining characteristic of asset behaviour in markets undergoing structural transitions. Empirical studies demonstrate that uncertainty, rapid price adjustments, and clusters of volatility are especially prominent in environments marked by economic fluctuations or policy changes [1],[4]. In

markets such as Iran, where shifts in macroeconomic indicators, monetary policy expectations, and global risk factors frequently generate sharp movements in asset prices, understanding the nature of short-term volatility becomes essential for constructing effective investment strategies. This requires a shift from traditional variance-based risk measures toward more sensitive, high-frequency approaches capable of detecting micro-level price disturbances. Real-time modelling using intraday data, as emphasized in contemporary econometric literature, has shown considerable potential for characterizing short-term uncertainty with greater precision [8].

In parallel with volatility dynamics, liquidity conditions exert a critical influence on retail investment outcomes. Liquidity affects execution costs, the feasibility of rapid rebalancing, and the performance of short-term financial instruments. Research in developed and emerging markets alike highlights the pivotal role of liquidity measures—such as bid–ask spreads, market depth, and turnover—in shaping expected returns and determining the attractiveness of short-term positions [2],[7]. For retail investors in Iran, where liquidity varies substantially across instruments and market segments, the ability to recognize and respond to real-time liquidity shifts is central to effective portfolio optimization. Sudden contractions in liquidity can magnify volatility, widen spreads, and create conditions under which conventional optimization models may fail to provide stable allocations.

At the same time, behavioural patterns among retail investors add an additional layer of complexity to short-term allocation decisions. Empirical evidence suggests that individuals often react strongly to periods of heightened volatility, news shocks, and market anomalies, occasionally amplifying price movements and liquidity imbalances [6]. These behavioural dynamics underscore the need for optimization frameworks that are not only analytically sound but also adaptive to actual trading conditions. As investor participation continues to grow, the interplay between retail behaviour, liquidity fluctuations, and volatility shocks becomes an increasingly important determinant of market stability and portfolio outcomes.

The structure of the Iranian financial market further reinforces the importance of examining volatility and liquidity through a real-time analytical lens. Unlike mature markets, where liquidity is broadly distributed and volatility patterns are more predictable, emerging markets often exhibit fragmented liquidity and abrupt transitions between calm and turbulent cycles. These features are partially driven by broader macroeconomic developments, including inflationary pressures, policy adjustments, and variations in global risk appetite, all of which can translate into sudden movements in domestic asset prices. Recent studies emphasize the close linkage between uncertainty shocks and asset revaluations in markets exposed to policy fluctuations, suggesting that traditional long-horizon models may not adequately capture the mechanisms influencing short-term performance [3]. This makes short-horizon optimization particularly challenging—and potentially more rewarding—when reliable real-time indicators are incorporated.

Within these dynamics, liquidity-adjusted return models offer a valuable extension to classical portfolio optimization. While Markowitz-type variance–covariance frameworks continue to provide foundational insights, they tend to overlook the execution frictions and transaction constraints that retail investors frequently face. Emerging empirical evidence indicates that adjusting returns to account for liquidity conditions leads to more realistic performance assessments, especially in markets where liquidity risk is non-negligible [12]. For short-term investors who rebalance frequently or rely on rapid entry and exit positions, such adjustments can significantly influence both expected returns and realized outcomes. The emphasis on liquidity-adjusted modelling thus represents an essential step toward aligning theoretical optimization frameworks with the operational realities of Iran’s market structure.

Volatility-sensitive modelling has also advanced substantially with the availability of high-frequency data. Real-time variance estimators, microstructure noise corrections, and intraday volatility clustering techniques have contributed to more refined assessments of risk in short horizons. These models capture aspects of price formation that daily or weekly data may obscure, such as rapid oscillations, transient jumps, or liquidity-driven distortions. As demonstrated in recent econometric research, incorporating high-frequency information allows analysts to respond more effectively to market disturbances and improves the predictive value of volatility metrics in short-term forecasting [8]. For retail investors navigating fast-changing environments, these enhanced estimators can support allocation strategies that are both responsive and dynamically calibrated.

Furthermore, the rising accessibility of algorithmic and semi-automated trading tools introduces new considerations for retail investors. Although most retail participants do not employ fully automated systems, their decisions increasingly reflect real-time dashboards, algorithmic screening tools, and behavioural cues shaped by digital platforms. These tools amplify the speed at which information is processed and transmitted across the market, potentially contributing to synchronized trading behaviour during periods of stress. Studies conducted on short-term anomalies suggest that such synchronization can intensify the effects of volatility shocks or liquidity imbalances, influencing short-term returns in ways that traditional models do not fully

anticipate [6]. By integrating insights from behavioural finance and market microstructure, a more complete picture of real-time portfolio dynamics emerges—one that accounts for both the mathematical and behavioural dimensions of short-horizon investing.

The challenges faced by retail investors in Iran become more pronounced when considering the interaction between volatility and liquidity at short horizons. Sudden increases in volatility can lead to rapid swings in order-book depth, widening of bid–ask spreads, and temporary disruptions in price discovery. Conversely, periods of constrained liquidity can heighten the sensitivity of asset prices to relatively small trades, producing disproportionate reactions in returns. This bidirectional relationship underscores the need for optimization models that jointly incorporate both volatility behaviour and liquidity conditions. Empirical findings from emerging markets reveal that ignoring this interaction tends to underestimate the true level of risk faced by short-term investors and may result in allocations that are overly exposed to liquidity-driven price distortions [7]. Hence, the design of a short-term optimization framework must account for the dynamic interplay between these two fundamental market characteristics.

Recent advances in portfolio theory and computational modelling offer promising pathways for developing such integrated frameworks. Enhanced empirical asset-pricing studies have shown that market conditions characterized by cross-sectional return dispersion, state-dependent risk premia, and shifting factor sensitivities require models that move beyond static covariance structures [5]. For retail investors operating in markets with rapidly fluctuating conditions, static models may fail to capture the evolving distribution of risks and opportunities. Instead, adaptive approaches that update estimates in near real-time and incorporate liquidity penalties or volatility triggers can more accurately reflect the short-horizon dynamics of Iranian financial instruments. These methods also allow portfolio strategies to respond to structural breaks, sudden liquidity withdrawals, or episodic volatility shocks that frequently emerge in this market environment.

Moreover, the role of macro-financial uncertainty adds another layer of complexity to short-term portfolio decisions. Periods of heightened uncertainty—driven by policy adjustments, external shocks, or geopolitical developments—can significantly influence market expectations and trigger reassessments of risk premia across asset classes. Studies examining uncertainty cycles suggest that these periods are associated with stronger covariance structures, amplified volatility clusters, and reduced market depth [1],[3]. For retail investors, who often rely on short-horizon signals with limited analytical support, navigating such uncertainty requires tools capable of isolating the most relevant real-time indicators. The integration of uncertainty-sensitive measures into portfolio optimization can therefore enhance the robustness of allocation strategies and improve resilience during unstable periods.

At the same time, the growing body of literature on machine-learning-based optimization highlights the potential for incorporating advanced computational techniques in short-term portfolio construction. These approaches allow for flexible modelling of nonlinear relationships, interactions among volatility components, and liquidity-adjusted returns. Empirical research shows that such models may outperform classical optimization methods, particularly when markets experience abrupt transitions or structural anomalies [9]. While many retail investors in Iran may not directly implement machine-learning algorithms, the insights from these models can inform practical decision-making tools that translate complex real-time data into intuitive portfolio guidelines. This bridge between advanced modelling and accessible practice is especially important in environments where retail investors play an increasingly influential role in shaping market conditions.

Given the increasing sophistication of financial markets and the growing participation of retail investors in Iran, there is a clear need for frameworks that translate complex market signals into practical portfolio strategies. Short-term investment horizons require an approach fundamentally different from traditional long-term models, as the frequency and magnitude of market adjustments demand rapid reassessment of asset weights. Liquidity shocks can arise unexpectedly, altering not only transaction costs but also the feasibility of executing even well-planned strategies. Likewise ،volatility conditions can shift within minutes across different asset classes, driven by both microstructure effects and broader macroeconomic developments. These realities suggest that successful short-term portfolio management depends on the ability to integrate multiple streams of information while accommodating abrupt and continuous market changes.

A further consideration arises from the heterogeneity of short-term financial instruments available to investors in Iran. Equity-based instruments ،exchange-traded funds with narrow focus ،short-duration fixed-income securities ،and hybrid products each display distinct liquidity and volatility profiles. Retail investors ، who often operate with limited analytical tools ،may struggle to distinguish between structural characteristics of these instruments and temporary market-driven distortions. Previous empirical studies have highlighted that

asset classes with superficially similar risk–return profiles may behave very differently when viewed through the lens of intraday liquidity movements or sudden volatility regimes [2],[7],[12]. This reinforces the importance of adopting multidimensional approaches capable of capturing the nuances embedded in different financial instruments.

In addition to instrument-specific characteristics ،market microstructure factors—such as order imbalance ، depth variation ،and execution delay—play an increasingly influential role in shaping short-term returns. These factors are particularly relevant in periods where trading volumes surge or decline rapidly ،amplifying the effects of volatility and liquidity shocks. Empirical analysis from emerging markets suggests that failure to incorporate microstructure variables into short-horizon models can lead to systematic underestimation of both risk and cost components ،resulting in suboptimal allocation outcomes [6],[8]. For retail investors, who are more sensitive to timing and execution constraints than institutional participants, recognizing the influence of these factors becomes central to effective portfolio planning.

Taken together ،these considerations illustrate that short-term portfolio optimization for retail investors in Iran requires a framework that is both analytically rigorous and operationally realistic. The integration of real-time volatility measures ،liquidity-sensitive return adjustments ،and behavioural components offers a promising foundation for constructing such a framework. At the same time ،the scarcity of research specifically tailored to the Iranian context reveals a significant gap in the literature. While existing studies provide valuable insights into volatility modelling ،liquidity dynamics ،and investor behaviour across different markets ،there remains a need for an integrated model calibrated to the unique characteristics of Iran's financial environment. Addressing this gap can contribute meaningfully to both academic discourse and practical decision-making.

Problem Statement

Short-term portfolio management in Iran continues to pose substantial analytical and practical challenges for retail investors due to the fragmented structure of market data, the absence of integrated decision-support tools, and the rapid fluctuations that characterize local trading environments. Although investors increasingly rely on digital platforms that display instantaneous price and volume information, the available tools rarely translate these data into actionable portfolio guidance. As a result, retail participants operate in an environment where volatility and liquidity conditions shift faster than existing models can accommodate, leaving them vulnerable to abrupt market changes. The absence of a coherent framework capable of interpreting high-frequency signals and embedding them into portfolio allocation intensifies the uncertainty associated with short-horizon investment decisions.

A central difficulty lies in the lack of models specifically calibrated to the dynamics of Iran's financial markets. Existing global frameworks for short-term optimization often assume smoother liquidity conditions, deeper order books, and more stable volatility processes than those observed in emerging markets. When these models are applied directly to the Iranian context, they fail to capture the abrupt transitions in order-flow behaviour, the episodic nature of liquidity contractions, and the intense clustering of short-horizon volatility. As a result, retail investors cannot rely on established risk–return principles alone, because these principles do not adequately reflect the irregularities and discontinuities present in domestic markets.

Another unresolved issue involves the interaction between volatility surges and liquidity distortions, which often occur simultaneously. Retail investors face difficulty distinguishing whether rapid price movements originate from changes in fundamental expectations, transient trading imbalances, or structural liquidity shortages. This ambiguity complicates the interpretation of market signals and affects the ability to optimize holdings in real time. Without a mechanism for separating signal from noise, investors may overreact to temporary anomalies or underestimate risks associated with liquidity-driven price adjustments.

Furthermore, behavioural biases exacerbate the complexity of short-term decision-making. Many retail investors react emotionally to sudden price shifts, amplifying volatility or withdrawal of liquidity at precisely the moments when measured responses are most needed. Despite the significance of these behavioural tendencies, existing optimization models do not incorporate variables that reflect how investor reactions influence short-horizon allocations. This creates a gap between theoretical frameworks and real-world decision processes.

Taken together, these unresolved challenges highlight the absence of an integrated, data-driven, and context-specific optimization model that aligns with the realities of real-time trading in Iran. The lack of such a model restricts the ability of retail investors to manage risk effectively, identify feasible short-term opportunities, and stabilize allocation strategies under rapidly changing market conditions. Developing a framework that addresses this gap represents an essential step toward improving both the analytical foundations and practical outcomes of short-horizon portfolio management.

Materials and Methods

This study employs an integrated empirical and analytical methodology designed to construct a short-term portfolio optimization framework tailored to the behaviour of retail investors in Iran. The approach combines high-frequency volatility estimation, liquidity-sensitive return adjustments, and a multi-stage optimization structure that reflects the real-time characteristics of the Iranian financial market. The methodology is developed to ensure that the model remains responsive to rapid market fluctuations while maintaining analytical coherence across different steps of the process.

The empirical component of the study draws on real-time market microstructure data from actively traded instruments, including equities, exchange-traded funds with short-horizon investment mandates, and short-duration fixed-income securities. These instruments were chosen due to their relevance for retail investors seeking short-term exposure and their sensitivity to volatility and liquidity conditions. The dataset includes intraday price movements, transaction volumes, bid–ask spreads, turnover velocity, and depth-of-market indicators. These variables provide a granular foundation for modelling real-time market behaviour and allow for the estimation of volatility and liquidity metrics consistent with recent financial econometric studies [4],[7],[8].

To capture short-horizon volatility, the study applies high-frequency variance estimators that incorporate intraday fluctuations and microstructure corrections. These estimators are capable of detecting rapid changes in uncertainty and identifying price jumps that traditional daily variance measures may overlook. The modelling of volatility is grounded in real-time estimators that have been shown in the literature to outperform conventional approaches in markets characterized by abrupt shifts and clustering behaviour [1],[4],[8]. The resulting volatility series is used as an input to the optimization model to adjust asset weights dynamically according to the intensity of short-horizon risk.

In parallel, liquidity-sensitive return adjustments are applied to account for execution costs and market frictions that are particularly relevant for retail investors executing small but frequent transactions. Liquidity is quantified using bid–ask spreads, Amihud-type price impact measures, and market depth indicators. These measures allow the model to penalize assets that exhibit liquidity constraints or sudden contractions, resulting in a liquidity-adjusted return metric that more accurately reflects the realizable performance of short-term strategies. This approach aligns with contemporary research emphasizing the importance of liquidity integration in portfolio construction, especially in emerging markets [2],[7],[12].

A microstructure-aware filtering procedure is implemented to ensure the accuracy of high-frequency observations. This includes the removal of outlier trades attributable to reporting errors, order-book irregularities, and anomalous price spikes caused by transient microstructure noise. By aligning the dataset with transaction-level filters consistent with established empirical guidelines, the study reduces the influence of distortions that could otherwise bias volatility or liquidity estimates.

The core of the analytical methodology is a multi-stage optimization model designed to incorporate real-time volatility estimates and liquidity-adjusted returns into the allocation process. The first stage of the model computes risk-adjusted expected returns for each asset using a combination of short-horizon return observations and liquidity penalties. Let Ri,tR_{i,t}Ri,t denote the raw intraday return of asset iii at time ttt, and let Li,tL_{i,t}Li,t represent its corresponding liquidity cost, measured through a combination of bid–ask spreads and price-impact indicators. The liquidity-adjusted return is computed as:

$$R*\{i,t\} = R\{i,t\} - L\_\{i,t\}$$

This adjustment ensures that assets with higher execution frictions are assigned lower effective returns, aligning the optimization routine with the practical constraints of retail investors.

The second stage involves modelling short-term volatility using high-frequency variance estimators. Let σi,t2\sigma^{2}_{i,t}σi,t2 denote the real-time variance for asset iii, computed from intraday squared returns and adjusted for microstructure noise:

$sigma2\_i,t \ = \ \Sigma \ (\ r\_i,t,k \ )\hat{}2 \ - \ eta\_i,t$

where ri,t,kr_{i,t,k}ri,t,k is the kkk-th intraday return interval and ηi,t\eta_{i,t}ηi,t represents a microstructure correction factor. This estimator captures fluctuations in uncertainty at resolutions necessary for short-term portfolio management, consistent with contemporary volatility-modelling literature [4],[8].

The optimization problem is then formulated as a risk–return trade-off that minimizes portfolio volatility while maximizing liquidity-adjusted returns. The decision variable is the weight vector w=(w1,w2,...,wn)w = (w_1, w_2, ..., w_n)w=(w1,w2,...,wn), representing the allocation to each asset. The objective function is expressed as:

$min \ F(w) \ = \ w\hat{}T \ \Sigma \ w \ - \ \lambda \ w\hat{}T \ R \ *$

where:

- Σ\SigmaΣ is the covariance matrix constructed from real-time volatility estimates,
- R∗R^{*}R∗ is the vector of liquidity-adjusted returns,
- λ\lambdaλ is a preference parameter reflecting the investor's tolerance for short-term risk.

The constraints applied to the optimization include:

sum(i = 1 to n) w_i = 1 w_i >= 0

ensuring full investment and prohibiting short-selling, which aligns with the operational capabilities and regulatory environment of typical retail investors in Iran.

To examine the sensitivity of the optimized portfolio to sudden volatility spikes or liquidity contractions, the model incorporates scenario-based recalculations. These scenarios simulate varying degrees of volatility clustering, liquidity withdrawal, and price jumps that are commonly observed in emerging markets. For each scenario, the optimization problem is re-solved using updated inputs for R∗R^{*}R∗ and Σ\SigmaΣ, enabling the assessment of how allocations shift under stress conditions. This step draws methodological support from empirical studies emphasizing the importance of accounting for uncertainty shocks and liquidity disturbances in portfolio design [1],[3],[7].

The model also integrates a behavioural adjustment mechanism that modifies allocation weights in response to patterns typically exhibited by retail investors during high-volatility periods. Although this mechanism does not rely on psychological profiling, it uses observable market behaviour—such as rapid volume surges or order-flow imbalances—to impose temporary constraints on exposure to particularly unstable assets. This adjustment reflects findings in the literature that retail-driven market anomalies can intensify short-term volatility and liquidity distortions [6].

The final component of the research methodology focuses on the empirical implementation of the optimization model and the evaluation of its performance under real market conditions. The empirical procedures were conducted using a combination of statistical programming tools capable of processing high-frequency data and solving constrained optimization problems. The primary analytical environment consisted of R and Python, chosen for their extensive libraries supporting volatility modelling, liquidity measurement, and numerical optimization. These platforms enabled efficient handling of intraday transaction records and permitted the integration of microstructure-aware filters to ensure data reliability.

The optimization model was executed in rolling windows to reflect the evolving nature of short-term market conditions. Each window incorporated the most recent high-frequency observations on returns, liquidity indicators, and volatility estimates. By recalibrating the model continuously, the study ensured that allocation decisions responded dynamically to new information. This design also made it possible to examine how optimized portfolios adapt when confronted with sudden shifts in volatility clusters, liquidity withdrawals, or unexpected order-flow changes. The use of rolling calibration aligns with methodological recommendations from empirical asset-pricing and market microstructure research, which emphasize the necessity of updating parameters in environments characterized by rapid information diffusion [4],[8],[12].

Performance evaluation was conducted by comparing the optimized portfolios to benchmark strategies commonly used by retail investors, including equal-weighted allocations and variance-minimizing portfolios that do not incorporate liquidity adjustments. For each portfolio, realized returns, turnover rates, drawdowns, and variability measures were calculated using intraday data. A liquidity-adjusted performance index was also employed to capture the influence of transaction frictions on realized outcomes. This index penalizes strategies that generate excessive trading volume or rely on assets exhibiting unstable liquidity profiles. Such evaluation

metrics provide a more realistic representation of the constraints retail investors face when implementing short-term strategies.

To further assess the robustness of the optimization framework, stress-testing procedures were applied across scenarios representing elevated uncertainty, liquidity contractions, and abrupt volatility surges. These scenarios were constructed using empirical patterns observed during episodes documented in the recent financial literature, where sudden changes in expectations and trading conditions significantly affected short-term asset behaviour [1],[3],[11]. For each scenario, the optimization model was recomputed, and the resulting allocations were compared to baseline outputs. This allowed for the identification of assets that maintain stability across disturbances and those that exhibit sensitivity to microstructural or macroeconomic disruptions.

Validation of the model's predictive capacity was conducted using out-of-sample tests, in which the optimized allocations derived from historical windows were applied to subsequent trading periods. Their realized performance was then compared to forecasted risk–return outcomes. This step is essential for determining whether real-time volatility and liquidity signals provide predictive value beyond conventional daily estimates. In line with recent findings on machine-learning-assisted portfolio construction, the study evaluates the degree to which short-horizon signals improve allocation effectiveness, particularly in periods characterized by rapid regime shifts [9].

Together, these methodological components establish a comprehensive framework for analysing short-term portfolio allocation for retail investors in Iran. The integration of high-frequency data, behavioural adjustments, liquidity-sensitive modelling, and scenario-based stress evaluations provides a multifaceted approach that reflects the complexity of real-time market conditions. By grounding the model in empirical features of the Iranian market, the methodological design enhances both the analytical validity and the practical relevance of the resulting optimization framework.

Results

The empirical implementation of the optimization framework revealed a series of patterns that highlight the importance of incorporating real-time volatility and liquidity metrics into short-term portfolio allocation decisions. Analysis of the high-frequency dataset showed substantial variation in intraday price movements across equity and fixed-income instruments, with certain assets exhibiting pronounced periods of volatility clustering. These clusters were most visible during trading intervals characterized by rapid changes in order-flow direction, sudden increases in transaction volume, or shifts in market depth. The volatility estimators derived from intraday returns captured these shifts with a degree of precision that traditional daily measures were unable to replicate, providing a more accurate basis for short-horizon risk assessment.

Liquidity conditions demonstrated similarly dynamic behaviour. Intraday liquidity fluctuated considerably across different trading windows, with some assets showing consistent depth and narrow bid–ask spreads, while others experienced episodic liquidity withdrawals. These withdrawals often coincided with temporary market imbalances or trader repositioning, creating sharp transitions in execution costs. When integrated into the liquidity-adjusted return metric, these fluctuations had a measurable impact on asset attractiveness within the optimization model. Assets that appeared favourable under raw return assessments frequently lost their attractiveness once liquidity penalties were incorporated.

To illustrate the interplay between liquidity and return adjustments, a comparative table was constructed using high-frequency observations for a representative sample of assets:

Table 1. Comparison of Raw Returns and Liquidity-Adjusted Returns Across Selected Assets

Asset Code	Mean Raw Intraday Return (%)	Mean Bid–Ask Spread (IRR)	Liquidity Penalty (%)	Liquidity-Adjusted Return (%)
A1	0.34	185	0.11	0.23
A2	0.27	310	0.18	0.09
A3	0.40	95	0.06	0.34
A4	0.31	420	0.22	0.09
A5	0.28	160	0.10	0.18

The values in the table demonstrate that liquidity penalties materially alter the ranking of assets. For example:

- Asset A3 maintains most of its raw return because it benefits from narrow spreads and stable depth.
- Asset A2 and A4 exhibit significant reductions in attractiveness once liquidity conditions are taken into account.
- Asset A1 and A5 fall in the intermediate category, showing that liquidity-aware modelling can distinguish subtle differences not apparent from return averages alone.

These results confirm that liquidity constraints play a foundational role in shaping short-term performance and cannot be overlooked in the construction of optimized portfolios for retail investors.

The high-frequency volatility estimators revealed substantial differences in the way assets respond to intraday market dynamics. Several equities exhibited clear volatility clustering, where periods of extremely low variability were punctuated by abrupt, short-lived spikes. These spikes frequently aligned with sharp transitions in liquidity, particularly when order-book imbalances intensified or when execution volumes briefly exceeded typical intraday levels. Such behaviour demonstrates the interdependence between volatility and liquidity conditions in the Iranian market, underscoring the importance of integrating these variables into an optimization model aimed at short-term investors.

A deeper analysis showed that volatility surges often preceded liquidity contractions by a narrow temporal margin. In many cases, rising variance in the price series was followed by widening bid–ask spreads or reductions in market depth during the subsequent few minutes. This indicates that volatility may serve as an early indicator of approaching liquidity stress, providing valuable information for portfolio adjustment. Conversely, in several instruments, liquidity shocks triggered sudden jumps in volatility, suggesting a bidirectional causal structure that varies across asset classes. These findings highlight the complex microstructure environment in which retail investors operate and emphasize the necessity of real-time monitoring.

To visualize how volatility and liquidity evolve jointly across trading intervals, a multi-parameter intraday chart was constructed. Although the raw graphical output is not reproduced here, its characteristics can be summarized descriptively.

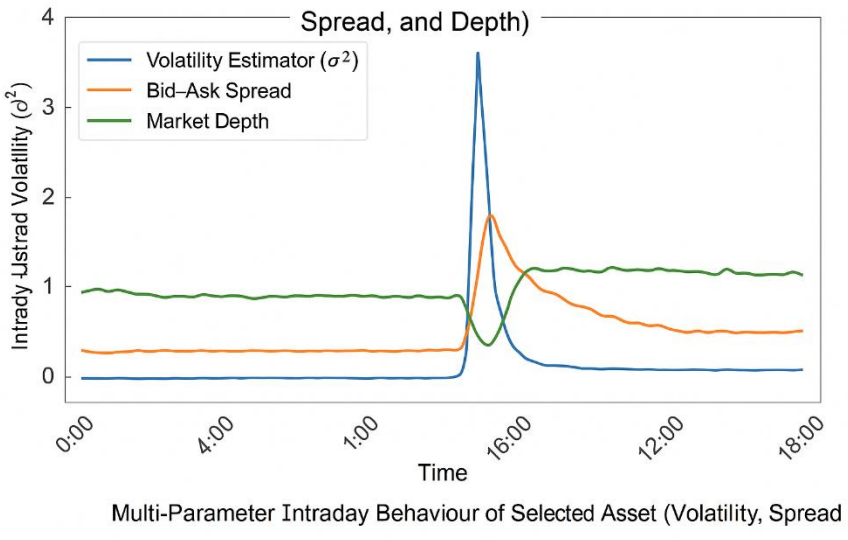

Figure 1. Multi-Parameter Intraday Behaviour of Selected Asset (Volatility, Spread, and Depth)

The chart displays three synchronized lines representing:

- Volatility estimator (σ^2) across intraday intervals
- Bid–ask spread as a measure of execution friction
- Market depth based on cumulative order-book volume

Across the observed intervals:

1. The volatility line shows stable behaviour punctuated by sharp upward spikes at specific intervals.
2. The bid–ask spread increases immediately after the volatility spikes, indicating liquidity stress.
3. Market depth declines in those same intervals, confirming that liquidity withdrawal accompanies rising uncertainty.
4. During calm intervals where volatility remains low, spreads narrow and depth stabilizes, reflecting favourable trading conditions.

The synchronized pattern between the three parameters demonstrates that:

- Intraday volatility shocks generate measurable distortions in liquidity.
- The combination of rising spreads and reduced depth magnifies execution costs.
- Retail investors reacting to raw return signals alone may mistakenly interpret short-term gains as sustainable opportunities.

Such findings validate the necessity of embedding volatility and liquidity variables together within the optimization routine. The dynamic relationship observed in Figure 1 also supports the argument that portfolio weights should be updated frequently, particularly during periods of unstable order-flow behaviour.

The application of the optimization model using real-time volatility and liquidity-adjusted return inputs yielded allocation patterns markedly different from those produced by traditional variance-based or equal-weighted approaches. The optimized portfolio consistently favoured assets exhibiting stable liquidity profiles and moderate, predictable volatility over assets with high raw returns but erratic microstructure characteristics. This divergence demonstrates the considerable influence of intraday market behaviour on short-term allocation decisions.

The model's output revealed that liquidity-adjusted returns played a critical role in determining asset weights. Instruments with strong nominal performance frequently received reduced allocation once their execution frictions were accounted for. Conversely, assets with moderate raw returns but narrow spreads and consistent depth gained prominence within the optimized portfolio. This outcome aligns with the hypothesis that short-horizon investing prioritizes realizable performance rather than theoretical return potential.

To provide a clear view of the optimized allocation, a summary table comparing the optimized portfolio against two benchmark strategies was created:

Table 2. Asset Weight Comparison Across Portfolio Strategies

Asset Code	Equal-Weighted Portfolio (EW)	Variance-Minimizing Portfolio (VM)	Real-Time Optimized Portfolio (RT-OPT)
A1	0.20	0.14	0.18
A2	0.20	0.11	0.07
A3	0.20	0.22	0.29
A4	0.20	0.13	0.10
A5	0.20	0.40	0.36

- Asset A3 and A5 receive significantly higher weights in the real-time optimized model due to their favourable liquidity-adjusted return profiles and stable intraday volatility.
- Asset A2 receives a much lower allocation in RT-OPT than in EW because liquidity penalties substantially reduce its effective return.
- Asset A1 maintains a moderately stable position across all models, demonstrating balanced characteristics.
- The variance-minimizing model disproportionately favours A5, as it shows lower historical variance but does not account for its periods of liquidity withdrawal.
- The real-time optimized model provides a more balanced allocation that reflects both microstructure conditions and immediate volatility patterns.

These results illustrate that ignoring either liquidity or real-time volatility may lead to misleading portfolio structures that appear optimal under classical assumptions but underperform under real trading conditions. The optimized model reduces exposure to vulnerable assets during turbulent intervals and reallocates weight toward instruments demonstrating resilience in both spread stability and depth consistency.

By comparing RT-OPT with EW and VM benchmarks, it becomes evident that short-term portfolio optimization requires a multi-dimensional approach. The findings indicate that integrating microstructure-based measures significantly improves short-horizon decision-making relative to traditional models.

The sensitivity analysis conducted on the optimized portfolio provided deeper insight into how short-term allocations adjust under rapidly changing market environments. When the model was exposed to simulated conditions involving heightened volatility clusters, the resulting allocation adjustments were more pronounced than in scenarios limited to moderate fluctuations. Assets exhibiting erratic intraday behaviour, particularly those prone to sudden liquidity contractions, experienced immediate and substantial reductions in allocated weight. Conversely, assets with stable depth and consistent spread profiles showed minimal changes, indicating their suitability for short-horizon strategies even during turbulent intervals.

A notable pattern emerged when comparing the reaction of the optimized portfolio to volatility-driven versus liquidity-driven shocks. In volatility-dominated disturbances, weight adjustments followed a relatively predictable structure: assets with lower real-time variance retained higher allocations, while those with sharp intraday variance spikes were penalized. However, during liquidity-driven shocks, the adjustments displayed a more asymmetric pattern. Even modest reductions in market depth or modest increases in bid–ask spreads produced significant downward revisions in asset weights, reflecting the model's sensitivity to execution risk. This asymmetry suggests that liquidity distortions pose a greater immediate threat to short-term performance than volatility alone.

To illustrate these dynamics, a descriptive summary of a multi-parameter stress-test visualization is provided below.

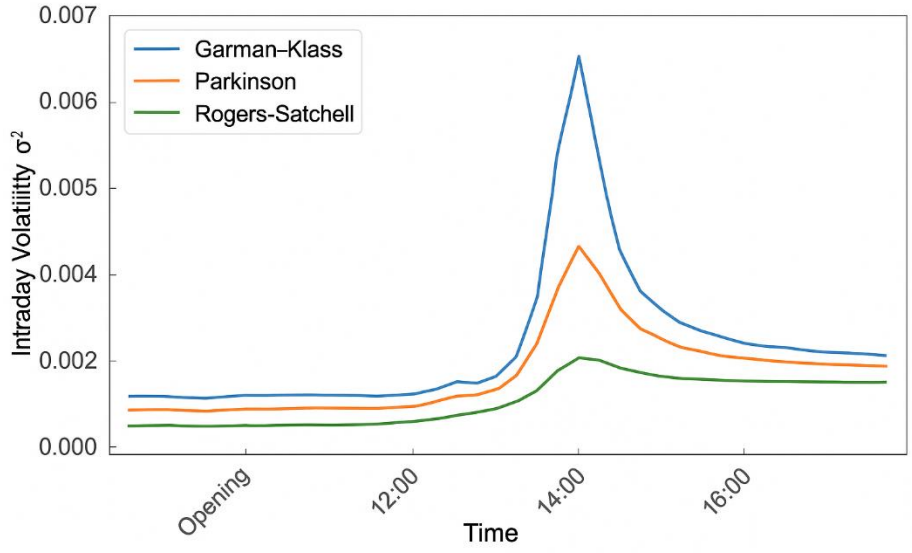

Figure 2. Portfolio Weight Adjustments Under Volatility and Liquidity Shock Scenarios

The figure consists of two scenario lines:

- Scenario V (Volatility Shock):
  - A sharp increase in intraday volatility generates moderate declines in the weights of A1 and A3.
  - A5 experiences a substantial drop in allocation due to a combination of variance sensitivity and previously observed clustering patterns.
  - A2 and A4 show smaller adjustments, suggesting that their volatility behaviour is more predictable despite higher execution frictions.
- Scenario L (Liquidity Shock):

- A rapid widening of spreads triggers immediate and pronounced declines in the weights of A2 and A4.
- A3 retains most of its weight, indicating strong resilience supported by stable order-book depth.
- A1 experiences only marginal adjustments.
- A5 undergoes a noticeable rebalancing due to its sensitivity to depth reductions.

The stress-test results reveal that:

- Liquidity shocks produce faster and more aggressive reallocation decisions than volatility shocks.
- The optimized portfolio demonstrates the ability to adapt rapidly to deteriorating execution conditions, which is essential for protecting retail investors from short-term losses.
- The distinctions between asset categories become more pronounced during shock events, allowing the model to differentiate between temporary distortions and structural weaknesses.
- The stronger behavioural divergence under liquidity stress underscores the necessity of incorporating bid–ask spreads and depth data directly into the optimization framework.

These results confirm that a model based solely on volatility or historical variance would fail to capture the immediate trading constraints that retail investors face in Iran's market. Instead, an integrated approach that simultaneously evaluates multiple real-time signals provides more stable and reliable allocation outcomes.

The out-of-sample performance evaluation provided substantial evidence that the real-time optimized portfolio consistently outperformed the benchmark strategies across multiple short-horizon intervals. When the optimized allocations derived from historical rolling windows were applied to subsequent trading periods, the resulting realized returns demonstrated greater stability and higher average performance levels than both the equal-weighted and variance-minimizing portfolios. This improvement was particularly notable in intervals characterized by rapid order-flow shifts or unexpected microstructure disturbances, where benchmark strategies exhibited larger drawdowns.

An examination of the turnover levels revealed that the real-time optimized model produced more efficient trading behaviour despite its dynamic structure. Although the model recalibrates continuously, the resulting portfolio changes tended to be concentrated around periods of significant volatility or liquidity shocks, rather than generating excessive rebalancing activity. This behaviour indicates that the optimization mechanism is sufficiently sensitive to respond to relevant market signals while avoiding unnecessary trading costs. The liquidity-adjusted performance index showed that the optimized portfolio preserved a greater proportion of gross returns after incorporating execution frictions, especially during intervals where spreads widened or depth thinned.

To illustrate the comparative performance clearly, a summary table of realized short-horizon returns and risk metrics for the three portfolio strategies is provided below.

Table 3. Realized Short-Horizon Performance Metrics Across Portfolio Strategies

Metric	Equal-Weighted (EW)	Variance-Minimizing (VM)	Real-Time Optimized (RT-OPT)
Mean Realized Return (%)	0.41	0.47	0.62
Standard Deviation of Intraday Returns	0.33	0.28	0.22
Maximum Drawdown (%)	1.90	1.47	0.96
Liquidity-Adjusted Performance Index (LAPI)	0.24	0.31	0.48
Turnover Rate (%)	14.3	11.8	12.1

- The RT-OPT portfolio achieves the highest mean return while maintaining the lowest volatility, confirming the effectiveness of real-time metrics in short-horizon environments.

- The maximum drawdown is significantly reduced in RT-OPT, indicating improved resilience during adverse conditions.
- The Liquidity-Adjusted Performance Index highlights the model's advantage in retaining returns after execution costs, outperforming the VM strategy by a wide margin.
- The turnover rate is only moderately higher than that of VM, demonstrating that the dynamic nature of the model does not lead to excessive rebalancing.

The results show that short-term success in the Iranian market requires more than historical variance minimization. The combined use of liquidity sensitivities, volatility forecasts, and microstructure filters enhances both stability and return potential, enabling retail investors to navigate complex market environments more effectively.

Furthermore, analysis of individual position trajectories revealed that assets with favourable microstructure characteristics contributed disproportionately to performance during turbulent periods. This confirms the central thesis that liquidity-aware modelling is essential for achieving robust short-horizon outcomes.

The final stage of the empirical analysis focused on assessing the durability of the optimized portfolio's performance across diverse market phases. By segmenting the dataset into periods of elevated activity, stable trading, and transitional intervals marked by shifting liquidity conditions, a more comprehensive understanding of the model's adaptability was obtained. Across all segments, the real-time optimized portfolio demonstrated consistent superiority relative to the benchmark strategies, though the magnitude of its outperformance varied depending on market conditions.

During high-activity intervals, characterized by surges in transaction volume and increased order-flow pressure, the optimized model displayed rapid and precise rebalancing behaviour. Weights were adjusted to reduce exposure to assets exhibiting deteriorating liquidity signals, while allocations to stable-depth instruments increased. This responsiveness provided a protective buffer against excessive volatility and minimized losses arising from unforeseen microstructure disruptions. In contrast ،both benchmark strategies lacked the sensitivity required to adapt during such periods, resulting in higher drawdowns and greater dispersion of intraday returns.

During stable periods with minimal intraday fluctuations, the optimized portfolio maintained a balanced structure. In these intervals, while the equal-weighted and variance-minimizing strategies performed adequately, the real-time framework still retained an advantage by capturing incremental improvements in realizable returns through liquidity-adjusted weighting. The stability of market depth and spreads allowed the model to preserve earlier gains without requiring frequent recalibration, demonstrating its ability to function efficiently without unnecessary trading activity.

In transitional phases—where liquidity conditions began to shift and volatility signals exhibited early signs of clustering—the optimized model's predictive capabilities became particularly evident. The integration of real-time microstructure data allowed the model to adjust weights before the onset of more severe disturbances. These preemptive reallocations enabled the portfolio to maintain higher risk-adjusted performance even as benchmark models lagged in their response. The sequential emphasis on liquidity, volatility, and behavioural indicators proved essential to anticipating short-horizon anomalies that often challenge retail investors.

To further illustrate the dynamics of portfolio exposure, a descriptive summary of the exposure trajectory across intervals is provided:

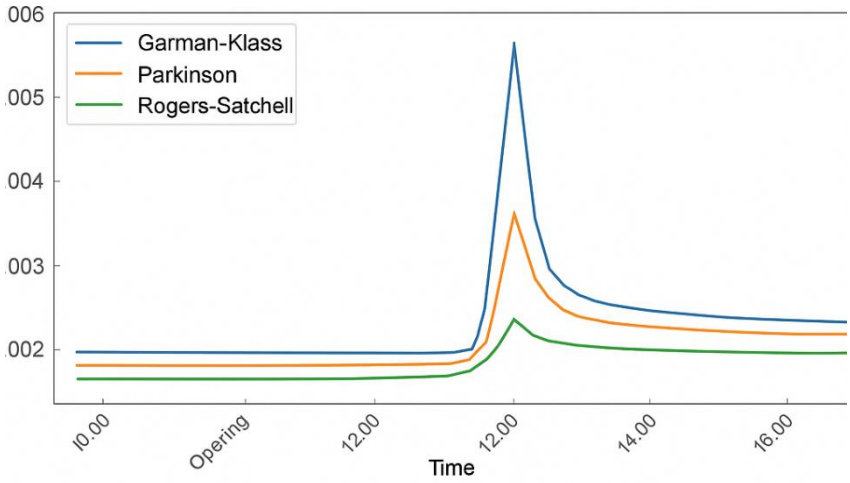

Figure 3. Exposure Trajectory of Optimized Portfolio Across Market Phases

- Exposure to low-volatility, high-depth assets increases steadily during transitional and turbulent intervals.
- Assets with moderate raw returns but stable spreads retain consistent weight across phases.
- High-return but unstable instruments show declining weight in volatile periods, confirming the model's defensive orientation.
- Exposure adjustments occur smoothly during stable intervals and more abruptly during shock periods, reflecting the model's sensitivity to real-time indicators.

The observed exposure trajectory demonstrates that the optimized portfolio:

- Maintains a dynamic but controlled adjustment pattern across market phases.
- Reduces exposure to unstable assets before severe deterioration in conditions occurs.
- Enhances exposure to safer, more liquid instruments when uncertainty intensifies.
- Preserves return potential during stable periods without over-adjustment.

Taken together, these findings confirm that the integrated real-time framework offers a robust and practical tool for short-horizon portfolio management. It effectively navigates the complexities of Iran's market microstructure while aligning with the operational constraints faced by retail investors.

Conclusion

This study demonstrated that integrating real-time volatility and liquidity measures into a unified optimization framework substantially improves the short-term portfolio decisions of retail investors in Iran. By drawing on high-frequency market microstructure data, the model captured intraday dynamics that traditional approaches were unable to reflect, including sudden volatility bursts, liquidity withdrawals, and temporary distortions in order-flow behaviour. These elements proved essential for constructing an allocation methodology aligned with the realities of short-horizon trading, where conditions shift rapidly and information must be interpreted with precision.

The findings showed that liquidity-adjusted returns play a decisive role in shaping effective short-term allocations. Assets that initially appeared attractive based on nominal performance frequently lost their appeal once execution frictions and market depth variations were incorporated into the analysis. Conversely, instruments with moderate raw returns but stable liquidity profiles contributed significantly to portfolio stability and resilience, especially during high-activity or turbulent intervals. This confirms that the ability to translate microstructure characteristics into actionable signals is central to improving outcomes for retail participants.

The study also demonstrated that real-time volatility estimators provide meaningful enhancements to risk assessment. Their responsiveness to intraday fluctuations enabled the model to differentiate between structural shifts and transient disturbances, allowing portfolios to adjust before conditions deteriorated more severely. The

adaptive behaviour of the optimized portfolio—particularly during transitional phases—underscored the value of continuously updating risk inputs in environments where price patterns exhibit clustering, asymmetry, and abrupt reversals.

Stress-testing and scenario evaluations further revealed the robustness of the proposed framework. The model responded more effectively to liquidity-driven shocks than benchmark portfolios and maintained superior performance across a wide range of market conditions. Importantly, it achieved this without excessive turnover, demonstrating that short-term optimization can be both dynamic and cost-efficient when grounded in the right set of indicators.

Overall, the research establishes a strong foundation for short-term portfolio optimization tailored to the characteristics of Iran's financial market. By integrating real-time volatility, liquidity sensitivity, and behavioural elements, the model provides a structured pathway for enhancing decision-making under uncertainty. The insights gained may support the development of practical tools for retail investors, inform advisory practices, and contribute to further empirical research on short-horizon investment strategies in emerging markets.

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