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Federated Learning Models for Privacy-Preserving Healthcare Analytics

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Abstract:
Emerging Markets (EMs) offer substantial growth opportunities but are simultaneously characterized by high financial volatility, institutional complexity, and structural risks inherent to developing economies. This paper analyzes the effectiveness of integrated risk governance structures in India, specifically examining the operational Financial Risk Management (FRM) frameworks of the National Stock Exchange (NSE) and Bombay Stock Exchange (BSE)—collectively referred to as National Stock Exchanges (NSC)—and their alignment with Strategic Planning (SP) objectives, assessed through the lens of the Balanced Scorecard (BSC) framework. Utilizing secondary data from academic journals, SEBI, RBI, and market statistics spanning 2015 to 2025, the study adopts a descriptive and analytical approach. Findings confirm that Indian Market Infrastructure Institutions (MIIs) maintain robust, internationally compliant operational FRM systems, highlighted by dynamic margin regimes (SPAN, Extreme Loss Margin) and a conservative Core Settlement Guarantee Fund (SGF) methodology designed to withstand extreme, plausible default scenarios. Strategically, recent regulatory reforms by SEBI (2025 IPO norms, particularly mandated institutional anchor participation) and RBI (the impending shift to the Expected Credit Loss—ECL—framework) demonstrate a clear, synchronized strategic shift toward enhancing systemic resilience by building domestic institutional capital buffers and strengthening forward-looking credit assessment. The analysis, however, reveals persistent market vulnerability stemming from high volatility persistence and significant contagion risk, particularly from the S&P 500 and European indices. The paper concludes that India's strategic planning utilizes non-financial perspectives of the BSC (Internal Processes and Customer) to address fundamental financial risks, recommending continued emphasis on macro-prudential policies and targeted surveillance to manage external volatility and domestic speculative activity.

Keywords: *Financial Risk Management, Strategic Planning, Emerging Markets, Balanced Scorecard, NSE, SEBI.*

1. Introduction

1.1 Background: The Imperative of Stability in Dynamic Markets

Emerging markets represent the fastest-growing segment of the global economy, yet they are perpetually challenged by a unique matrix of financial risks. These risks—encompassing credit, operational, market, legal, and exchange rate volatility—are often magnified by institutional voids, opaque regulatory environments, and high dependence on volatile foreign capital flows. For large capital market economies like India, maintaining financial stability while enabling accelerated growth necessitates the coupling of rigorous Financial Risk Management (FRM) practices with coherent, long-term Strategic Planning (SP).

The Indian capital market, anchored by the National Stock Exchange (NSE) and the Bombay Stock Exchange (BSE), has undergone massive regulatory and technological transformation over the last three decades, positioning it as a critical component of global finance. The efficacy of these Market Infrastructure Institutions (MIIs) in performing core functions—such as trading, clearing, and settlement—hinges entirely on the strength of their FRM frameworks, particularly those residing within their Clearing Corporations.

1.2 Problem Statement and Research Gap

Traditional financial analysis often addresses FRM mechanisms (like Value-at-Risk or margin models) separately from strategic objectives (such as market depth or global competitiveness). This segregated approach fails to capture how regulatory bodies and MIIs deploy strategic policy to mitigate structural risks. The central problem addressed by this research is the systemic need in EMs for a unified, holistic framework that aligns operational risk control with strategic market development.

The research gap lies in systematically evaluating the strategic coherence of the Indian regulatory ecosystem (comprising SEBI, RBI, NSE, and BSE) using a recognized strategic tool. This paper addresses this gap by employing the **Balanced Scorecard (BSC)**, a strategic management framework, to analyze how recent, pivotal regulatory changes (2025 reforms) translate into measurable outcomes across financial, customer, internal process, and learning/growth perspectives, ensuring that short-term stability measures reinforce long-term strategic goals.

1.3 Research Objectives and Contributions

The primary objectives of this study are:

1. To evaluate the strength and sophistication of the operational FRM mechanisms employed by the NSE and BSE, specifically focusing on clearing and settlement risk mitigation structures.
2. To analyze the strategic coherence and alignment of recent macro-level regulatory reforms (SEBI and RBI, post-2024) within the context of the Balanced Scorecard (BSC) framework.
3. To empirically discuss the persistent nature of market risk in India, including high volatility and vulnerability to global financial spillover effects, and to derive data-driven policy recommendations for enhancing systemic resilience.

This research contributes to the academic literature by providing a novel, integrated assessment of FRM and SP in a leading emerging market, offering actionable insights for policymakers seeking to manage the complex duality of rapid growth and inherent volatility.

2. Review of Literature

2.1 Financial Risk Management in Emerging Markets (EMs)

The literature universally recognizes that EMs face higher-than-average financial risks. These risks are multi-layered, extending beyond standard credit and market volatility to include significant legal, operational, and exchange rate exposures. The rapid pace of market integration, particularly following global crises such as the 2008 financial crisis, has rendered EMs increasingly vulnerable to external shocks, characterized by tumbling currencies, rising inflation, and heavy dependence on foreign capital.

Managing risk in this context is complicated by institutional deficiencies and structural challenges. In EMs, the processes for calculating fundamental risk metrics, such as correlations and volatilities using historical data, are aggravated because market movements tend to be higher and shifts in economic fundamentals are often abrupt and radical. Furthermore, liquidity for many financial instruments is often lower. Academic consensus stresses that effective FRM in EMs requires innovative approaches that incorporate macro-prudential factors like liquidity, contagion, and timescale interactions into integrated assessment models.

2.2 The Balanced Scorecard (BSC) as a Strategic Planning Tool

The Balanced Scorecard (BSC), pioneered by Kaplan and Norton, is a critical strategic management framework that moves beyond traditional financial metrics to provide a comprehensive, holistic view of organizational performance. The BSC assesses performance across four primary perspectives: Financial, Customer, Internal Processes, and Learning and Growth.

For Market Infrastructure Institutions (MIIs) like the NSE and BSE, the BSC is exceptionally relevant. It allows the translation of abstract regulatory strategies (e.g., promoting market integrity or investor protection) into measurable outcomes. The Financial perspective covers short-term profitability and capital adequacy. The Customer perspective addresses investor confidence and market access. The Internal Processes perspective focuses on operational efficiency, such as clearing robustness and technological deployment. Finally, the Learning and Growth perspective measures the capacity for innovation, digital transformation, and adaptation to global best practices. The linkage of these perspectives is fundamentally causal, making the BSC an effective diagnostic tool for assessing the strategic coherence of India's risk-growth objectives.

2.3 Regulatory Governance and Risk Mitigation in Indian Capital Markets

The institutional framework for financial stability in India is dual, involving the Securities and Exchange Board of India (SEBI) regulating capital markets and the Reserve Bank of India (RBI) overseeing banking and monetary policy. Both the NSE and BSE operate as demutualized, nationwide exchanges, performing crucial regulatory and surveillance functions under SEBI's oversight.

A key development in the Indian market has been the substantial growth of the derivatives segment, which facilitates the management of financial risk. However, this growth, especially in exchange-traded derivatives, has amplified potential leverage risk, particularly concerning short-term index options and speculative activity among retail investors. This reality necessitates a continuous evolution of regulatory frameworks to ensure robust risk management practices, including mandatory risk-based assessments for derivative offerings and strict compliance with SEBI Listing Obligations and Disclosure Requirements.

3. Research Objectives and Methodology

3.1 Specific Research Objectives

The research is guided by the objectives established in Section 1.3:

1. To evaluate the efficacy of operational FRM mechanisms (SGF, margin systems) of the NSE and BSE.
2. To analyze the strategic linkage of 2025 regulatory reforms (SEBI/RBI) to capital market stability using the four perspectives of the BSC.
3. To quantify and characterize the vulnerability of the Indian market to global volatility and liquidity dynamics.

3.2 Research Design: Descriptive and Analytical Secondary Data Review

This study employs a descriptive and analytical research design. The research is non-empirical in the primary sense, relying exclusively on an intensive review and synthesis of existing secondary data. This approach is necessitated by the requirement to adhere strictly to secondary data utilization norms for publication, drawing deep insights from published figures and policy documents. The analysis focuses on synthesizing theoretical models (BSC, agency theory) with practical applications evidenced in regulatory actions and market data.

3.3 Data Sources and Validation

Data were collected from verifiable public domain sources, adhering to the stringent standards required for academic submission:

- **Institutional and Regulatory Reports:** Annual reports, integrated reports, and official circulars published by SEBI , RBI , NSE , and BSE.
- **Market Statistics:** Statistical bulletins providing quantitative metrics on volatility, liquidity (Impact Cost), and derivative turnover.
- **Academic Literature:** Peer-reviewed journals and institutional white papers focusing on emerging market finance, risk management practices in India, and the application of strategic performance frameworks.

The use of data from SEBI's September 2025 bulletins and academic studies focusing on 2021–2024 periods provides a contemporary foundation for assessing recent regulatory impacts and market dynamics.

4. Data Analysis and Discussion

4.1 Operational Financial Risk Management (FRM) Frameworks of NSE and BSE

The foundational robustness of the Indian capital market rests on the operational FRM of its Clearing Corporations (CCs), notably NSE Clearing (NCL) and its counterparts. These CCs manage settlement risk, primarily through the core mechanisms of the Central Counterparty (CCP) and dynamic margining.

4.1.1 The Central Counterparty Mechanism and Novation

The CCs perform the vital function of *novation*, stepping in as the counterparty to every trade and guaranteeing the settlement obligations of trading members. This assumption of counterparty risk is crucial in volatile emerging markets where individual broker defaults could otherwise trigger systemic cascade failures.

4.1.2 Core Settlement Guarantee Fund (SGF)

The SGF is the ultimate financial buffer against member default risk. NSE Clearing maintains a Core SGF in each segment, guided by the methodology prescribed by SEBI. Crucially, the minimum required corpus of the Core SGF is determined using a **stress test** model designed to cover the worst-case loss incurred by the **top two members** causing the highest credit exposure. This sophisticated, conservative methodology indicates that the operational FRM framework is not merely compliant but designed to address systemic risk concentration, focusing regulatory capital against the largest potential points of failure, which is a necessary precaution in markets prone to abrupt financial distress.

4.1.3 Margin System Efficacy (SPAN and Extreme Loss Margin)

The margin system is the first line of defense against client default. In the Equity Derivatives (F&O) segment, Trading Members are mandatorily required to collect SPAN margin and Extreme Loss Margin (ELM) upfront from clients. These margins are calculated dynamically using volatility metrics. The system requires members to have prudent risk management policies and liquidity safeguards, further reinforced by the ability to accept various forms of collateral. The dynamic, volatility-based adjustment of these margins ensures that the risk coverage adapts immediately to changes in market conditions, essential for limiting the high leverage risk associated with India's substantial derivatives activity.

4.2 Strategic Alignment: Mapping Regulatory Reforms (SEBI/RBI 2025) to the Balanced Scorecard (BSC)

BSC Perspective	Strategic Objective (MIIs/Regulators)	Corresponding Indian Initiative/Metric
Financial	Maximized Capital Market Stability and Growth	Implementation of ECL Framework, Capital Adequacy via Revised Basel III.
Customer	Enhanced Investor Confidence and Market Depth	Preservation of Retail Quota, Increased Domestic Anchor Investor Allocation (40%).
Internal Processes	Operational Efficiency and Risk Mitigation	Core SGF corpus methodology, Dynamic Margin System (SPAN/ELM), Cybersecurity Framework (CSCRF).
Learning and Growth	Regulatory Modernization and Institutional Adaptation	Transition to ECL Framework, Adoption of Integrated Reporting, Investor Awareness Test.

4.2.1 Financial and Learning & Growth Perspectives: Strengthening Systemic Capital Buffers

The RBI's proposal to implement the Expected Credit Loss (ECL) provisioning framework for scheduled commercial banks (starting April 2027) represents a fundamental strategic shift. Moving away from the incurred loss model to a forward-looking *expected loss* model strengthens credit risk management significantly by requiring banks to provision upfront for potential deterioration. This adoption aligns with global best practices (IndAS) and achieves two critical strategic outcomes: it stabilizes the banking sector (Financial perspective) and mandates institutional modernization (Learning and Growth perspective). By ensuring all major financial institutions operate under a unified, stringent, forward-looking provisioning standard, the regulator strategically reduces the risk of contagion spreading from potential banking sector instability to the broader capital market. Furthermore, the Revised Basel III guidelines, which propose a standardized approach for credit risk and lower risk weights for specific sectors, further stabilize the overall financial system.

4.2.2 Customer/Market Perspective: Depth and Stability through Strategic Localization

SEBI's 2025 IPO reforms exemplify how strategic planning is being actively used to mitigate liquidity and systemic risk. These reforms eased Minimum Public Shareholding (MPS)
requirements for large issuers and, critically, enhanced the allocation for anchor investors from one-third to 40%. This

initiative serves the Customer perspective by providing a smoother path for large corporations seeking listing, which increases market depth.

More strategically, the reforms mandated that an extra 7% of this anchor allocation be reserved specifically for domestic institutional investors, such as LIC and pension funds. This move leverages regulatory policy to build a robust domestic defense mechanism against abrupt foreign portfolio investor (FPI) withdrawals—a classic vulnerability for emerging markets facing high volatility and high dependence on foreign capital. By tethering the stability of critical large IPOs to patient, long-term domestic institutional capital, the regulator is strategically mitigating external liquidity risk, effectively embedding FRM objectives within the Customer/Market development perspective of the BSC.

4.3 Empirical Discussion on Volatility, Liquidity, and Global Spillover

While India's operational and strategic FRM structures are sound, empirical data highlight persistent challenges in managing behavioral and external risks.

4.3.1 Liquidity and Volatility Indicators

Analysis of liquidity metrics (Impact Cost) for component stocks of the S&P BSE Sensex during August 2025 shows extremely high efficiency, with the Impact Cost recorded as predominantly 0.0% for major scrips. This suggests that for high-volume, blue-chip stocks, transaction costs are negligible, indicating robust market execution mechanics.

However, high liquidity coexists with high stock-specific volatility. During the same period, Sensex components exhibited significant daily volatility, with stocks like TRENT LTD. registering 2.6% and BHARAT ELECT registering 2.0%. This juxtaposition of low operational friction (low Impact Cost) and high price movement (high volatility persistence) suggests that systemic risk is not primarily driven by failures in operational mechanics but by structural macroeconomic uncertainty, leveraged derivative speculation, and external factors.

The high volume in currency derivatives(e.g.,NSE currency futures turnover was ₹42,834 crore in August 2025) further confirms the pervasive use of leverage, necessitating the continued efficacy of SPAN and ELM systems to protect the CCs.

4.3.2 Global Contagion and Volatility Persistence

The most significant residual risk for the NSE lies in its vulnerability to global spillover effects. Empirical studies using advanced econometric models (DCC-GARCH and Wavelet analysis) reveal that the NSE, while demonstrating resilience through rapid post-shock adjustments, remains vulnerable to substantial contagion, particularly from the S&P 500 and European indices.

The persistent but fluctuating correlation identified between the NSE and these major indices implies that global macroeconomic and geopolitical shocks can periodically compromise Indian market stability, regardless of strong domestic controls. This inability to fully decouple from global market movements means that FRM strategies must prioritize external monitoring and international regulatory cooperation. The strategic focus, therefore, must shift beyond domestic operational excellence toward mitigating the propagation of volatility originating from advanced economies.

5. Findings

5.1 Effectiveness of Operational FRM

The analysis confirms that the operational FRM of the NSE and BSE clearing corporations is sophisticated and robust. The Core SGF structure, defined by stress tests covering the top two exposure-generating members, ensures a high degree of systemic resilience against counterparty and settlement risk. Furthermore, the mandatory, upfront collection of dynamic margins (SPAN and ELM) across the highly active derivatives segment provides essential protection against leverage-induced client defaults.

5.2 Strategic Coherence and BSC Alignment

Regulatory actions taken by SEBI and RBI, particularly the 2025 reforms, exhibit strong strategic coherence when mapped against the BSC framework. The adoption of the ECL framework and the push for revised Basel III norms are crucial elements addressing the Financial and Learning & Growth perspectives by ensuring forward-looking credit assessment and strengthening capital adequacy. Most notably, the strategic decision to prioritize domestic institutional funds in IPO anchor allocations addresses the Customer perspective (market depth) while simultaneously performing a critical FRM function: insulating the market against the volatility of FPI flows.

5.3 Persistent Gaps: External and Behavioral Risks

Despite strong internal controls, the primary residual risk factors are external contagion and behavioral activity. The high volatility observed in market indicators, coupled with empirical evidence of persistent spillover effects from global indices (S&P 500, European markets), confirms that India's FRM systems must be increasingly oriented toward macro-prudential and geopolitical risk management. Furthermore, the surge in speculative derivative trading demands continuous intensification of surveillance (e.g., AI-based algorithmic risk detection) to curb potential behavioral biases and excessive leverage that could disrupt market efficiency.

6. Suggestions / Policy Recommendations

The findings necessitate policy recommendations that shift the emphasis from purely operational risk mitigation to macro-prudential stability and external vulnerability management.

6.1 Enhancing Macro-Prudential Buffers and Institutional Adaptation

The RBI must ensure the smooth, timely implementation of the Expected Credit Loss (ECL) framework by April 2027, minimizing any one-time impact on bank provisioning while maximizing the long-term benefits of forward-looking credit risk management. This commitment to the Learning and Growth perspective of the BSC, by modernizing risk assessment standards, must be maintained rigidly to enhance overall financial stability and confidence. Policymakers should also leverage the strategic potential of financial governance tools, such as the adoption of Integrated Reporting (IR), which provides stakeholders with comprehensive insights into value creation across economic, environmental, and social dimensions, thereby reinforcing confidence in corporate stability.

6.2 Mitigating External Contagion through Targeted Surveillance

Given the confirmed vulnerability of the NSE to volatility spillover from major advanced markets , SEBI should enhance cooperation agreements with international regulators (e.g., banking and broker-dealer regulators) to harmonize monitoring standards. Furthermore, the establishment of internal trigger mechanisms based on the volatility indices of identified high-correlation markets (like the S&P 500 and relevant European indices) could enable the pre-emptive adjustment of domestic margin requirements, providing an additional layer of macro-prudential defense against anticipated external shocks.

6.3 Sustaining Strategic Localization and Governance

The strategic policy of utilizing domestic pension and insurance funds as institutional anchors must be sustained and potentially expanded. By deepening the involvement of patient domestic capital, India strategically fortifies its liquidity against the inherent flightiness of FPIs, cementing the long-term resilience of capital formation initiatives. Furthermore, MIIs must formalize their strategic goals using the BSC to ensure that large investments in technological interventions—such as AI-based surveillance, digital transformation, and the Cybersecurity and Cyber Resilience Framework (CSCRF) —are directly linked to measurable improvements in operational stability and governance, thus justifying expenditure in the Internal Processes and Learning and Growth perspectives.

7. Conclusion

Financial risk management and strategic planning are inseparable pillars supporting the long-term viability of India's capital markets. The NSE and BSE have established world-class operational FRM mechanisms, effectively neutralizing settlement and counterparty risk through robust CCP structures, dynamic margining, and conservative SGF models. However, the true transformation lies in the strategic deployment of regulatory policy. Recent reforms by the RBI and SEBI, particularly the adoption of the ECL standard and the strategic localization of institutional investment through IPO anchor allocations, demonstrate a nuanced understanding of emerging market fragility. These policies actively use the non-financial levers of the Balanced Scorecard—Learning & Growth and Customer focus—to build structural defenses against traditional Financial risks (credit and FPI dependency). While operational risk is managed effectively, the persistent threat posed by external contagion and domestic speculative derivatives activity remains the primary challenge. Future stability hinges on the effective implementation of these macro-prudential policies and the continuous refinement of surveillance mechanisms to anticipate and neutralize volatility driven by both global shocks and behavioral finance anomalies

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