

An Integrated Quantitative Risk-Scoring Model for Financial Institutions Using Multi-Factor Indicators

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ABSTRACT

Financial institutions operate in an environment where credit, market, liquidity, operational, model, and conduct risks interact nonlinearly and can amplify each other through feedback loops. Traditional “silo” risk management often fails to capture these interactions, creating blind spots in capital planning, risk appetite calibration, and crisis response. Building on enterprise risk management (ERM) evidence and recent advances in stress testing, risk data governance, and board-level risk oversight, this paper proposes an **Integrated Risk Management Model (IRMM)** for banks and other regulated financial institutions. The IRMM combines (i) governance and accountability via an enhanced lines-of-defense structure, (ii) a unified risk taxonomy and common measurement language, (iii) scenario-driven aggregation across balance sheet and income statement, and (iv) continuous monitoring with risk appetite triggers tied to decision rights. The model is presented as a practical operating system with clear artifacts (risk appetite statements, scenario library, risk register, model inventory, capital/liquidity dashboards) and an implementation roadmap. Comparative analysis shows that IRMM operationalizes ERM principles while strengthening cross-risk aggregation and actionability, addressing gaps frequently observed in real-world ERM maturity. Empirical and conceptual literature supports the model’s expected benefits: lower default risk and improved governance quality when ERM is effectively implemented [2], [1], and improved performance when risk committees are strong and structurally capable [3].

1. Introduction

Financial institutions are inherently risk businesses. Their profitability depends on transforming maturities, pricing credit, intermediating markets, providing payments, and offering financial services under uncertainty. The same features that make banks productive (leverage, interconnectedness, maturity mismatch) also make them fragile, especially when risks interact: for example, a credit shock worsens market valuations, damages liquidity, increases funding spreads, and triggers operational stress through collections and restructuring workloads.

Many institutions still run risk in separate verticals (credit, market, operational, liquidity) with separate tools, data, and metrics. This fragmentation can delay escalation, produce inconsistent views of “how much risk we are taking,” and weaken governance. Research on risk governance highlights that moving beyond traditional risk management toward ERM requires explicit governance mechanisms, responsibilities, and organization-wide risk awareness [1]. Evidence from banking indicates that stronger ERM implementation is associated with lower default risk [2]. Governance mechanisms such as board-level risk committees can amplify ERM’s performance effects when they are

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structurally strong, not just nominal [3]. These findings imply that integration is less about adding more reports, and more about building an operating model that converts risk information into timely decisions.

This paper proposes an **Integrated Risk Management Model (IRMM)** that connects governance, risk identification, measurement, aggregation, reporting, and action. IRMM is designed to work for banks, NBFCs, insurance-adjacent finance firms, and fintechs with material balance-sheet risk. It emphasizes (a) a common risk language and data governance, (b) scenario-based aggregation across risk types, and (c) decision rights tied to risk appetite thresholds.

Table 1. Typical bank risk interconnections (illustrative)

Primary shock	Secondary transmission	Where silo models fail
Credit deterioration	Higher provisions reduce capital; funding spreads widen	Credit vs treasury disconnect
Market volatility	Collateral calls pressure liquidity	Market risk not tied to funding plan
Liquidity stress	Fire sales create market losses; credit tightening increases defaults	Liquidity metrics not linked to portfolio actions
Operational event (fraud/outage)	Conduct penalties; customer churn; liquidity run risk	Ops risk not tied to reputation/run dynamics
Model error	Mispriced credit/market exposures; wrong hedges	Model risk not embedded in business approvals

2. Literature Review and Motivation

2.1 ERM value, governance, and outcomes

ERM is commonly described as a holistic approach to managing the portfolio of risks rather than isolated categories. The empirical banking literature provides strong motivation for integration. A key banking study finds that stronger ERM implementation is associated with **lower default risk** [2]. Related work explains why firms adopt risk governance as the step that distinguishes ERM from traditional risk management, focusing on accountability structures and organization-wide awareness [1].

Governance quality matters. A large-sample study shows ERM effectiveness relates positively to firm performance, and that **strong board-level risk committees** complement and strengthen this relationship [3]. However, ERM's impact can vary by context and maturity; some studies find limited performance effects in certain samples and stress the need for real integration, not just formal adoption [4]. This mixed evidence suggests that implementation design is critical.

2.2 Stress testing and scenario aggregation

Stress testing has evolved from a regulatory compliance exercise into a strategic tool for capital and liquidity steering. A stochastic simulation framework for bank stress testing demonstrates how scenario-based approaches can estimate financial fragility and probability of default using balance-sheet dynamics [6]. Scenario aggregation is essential because it naturally integrates credit, market, and liquidity effects into one story that leadership can act on.

2.3 Data governance and risk reporting capability

Integration requires reliable, well-governed data and consistent definitions across systems. Research on banking risk data compliance emphasizes structured action plans combining data governance and master data management to enable effective risk data management and reporting [7]. Without this layer, integrated analytics degrade into debates over data rather than decisions.

2.4 Lines of defense and accountability

Clear accountability remains a common failure point. Modern interpretations of the lines-of-defense model highlight the need to clarify roles, avoid duplications, and strengthen governance structures [8]. Expanded versions tailored to financial institutions add external audit and regulators as additional layers of discipline, reinforcing system-wide accountability [9].

Table 2. Selected literature underpinning IRMM

Theme	What the literature indicates	Key sources
Risk governance	ERM requires governance mechanisms beyond silo risk mgmt	[1]
ERM outcomes in banking	Stronger ERM linked with lower default risk	[2]
Risk committee effectiveness	Committee strength magnifies ERM performance benefits	[3]
Mixed performance evidence	ERM impacts depend on maturity and design	[4]
Stress testing integration	Scenario simulation can capture fragility/default dynamics	[6]
Risk data governance	Data/MDM action plans enable effective aggregation	[7]
Accountability structures	Updated lines-of-defense clarifies roles	[8], [9]

3. Research Approach and Design Principles

This paper is design-oriented: it synthesizes evidence from ERM governance research, stress testing frameworks, and risk data governance to propose an integrated, implementable model. The IRMM is guided by six design principles:

1. **Single risk language:** consistent taxonomy, definitions, and measurement hierarchy.
2. **Decision-first reporting:** dashboards exist to trigger decisions, not to “inform.”
3. **Scenario-driven aggregation:** integration occurs through scenarios that flow across P&L, capital, and liquidity.
4. **Clear decision rights:** each threshold has an owner and an action playbook.
5. **Model governance embedded in business flow:** model risk is not an afterthought.
6. **Continuous control loop:** monitor → learn → recalibrate appetite and limits.

Table 3. IRMM design principles mapped to practical artifacts

Principle	Artifact	Example deliverable
Single risk language	Risk taxonomy + data dictionary	Common definitions for PD, LGD, VaR, LCR
Decision-first reporting	Risk appetite dashboard	Green/amber/red triggers with actions
Scenario aggregation	Scenario library	Macro, sectoral, idiosyncratic scenarios
Decision rights	RACI + escalation matrix	Who acts at 80% limit vs 100% breach
Embedded model governance	Model inventory + change control	Approval workflow for new scorecards
Continuous loop	Review cadence	Monthly risk review + quarterly appetite reset

4. The Integrated Risk Management Model (IRMM)

IRMM is an operating model with four layers:

1. **Governance layer (Who decides):** board risk committee, management risk committee, CRO function, business risk owners, internal audit, and independent validation.
2. **Risk architecture layer (What we manage):** unified taxonomy, risk register, control library, model inventory, and risk appetite framework.
3. **Analytics layer (How we measure):** risk quantification engines (credit, market, liquidity, operational), scenario and stress testing engine, and aggregation into economic and regulatory views.
4. **Execution layer (How we act):** limit management, capital/liquidity steering, product pricing gates, portfolio actions, contingency funding plan triggers, and incident response.

4.1 Governance: enhanced lines-of-defense with decision rights

IRMM uses the lines-of-defense concept but makes it operational: each line has defined outputs and escalation responsibilities. Updated governance discussions emphasize clarity and alignment across governance functions [8], and a five-lines-of-defense view explicitly recognizes external audit and regulators as part of the broader control ecosystem for financial institutions [9].

4.2 Risk appetite as the “control knob”

Risk appetite translates strategy into constraints. Under IRMM, appetite is expressed across capital (e.g., CET1 buffers), liquidity (LCR/NSFR), earnings volatility, credit loss tolerance, concentration limits, and operational resilience metrics. Appetite is then linked to triggers and playbooks.

4.3 Scenario integration: the heart of the model

Rather than forcing every risk type into one metric, IRMM integrates through scenarios that update:

- **Credit:** PD/LGD shifts, migration, defaults, provisions (including ECL dynamics).
- **Market:** valuation shocks, basis risk, interest rate moves.
- **Liquidity:** funding run assumptions, collateral haircuts, margin calls.
- **Operational:** outage/fraud loss, recovery time, conduct impacts.

These jointly produce paths for net interest income, impairments, trading income, capital ratios, and liquidity buffers. A stochastic stress testing approach illustrates how simulation can capture fragility and default probability dynamics [6].

Table 4. IRMM blueprint: layers, components, and outputs

Layer	Components	Output to management
Governance	Risk committee structure, escalation rules	Decisions, approvals, remediation mandates
Architecture	Taxonomy, risk register, appetite framework, controls	“What matters” + ownership + thresholds
Analytics	Risk engines + scenario aggregation + validation	Forward-looking risk and capital/liquidity impact
Execution	Limits, pricing gates, portfolio actions, CFP	Actions taken + tracked impact + learning loop

5. Quantification and Aggregation Methods

5.1 Credit risk

Credit remains the dominant risk for most lenders. IRMM uses multi-horizon metrics:

- Point-in-time and through-the-cycle PDs (for pricing vs capital).
- Stage migration metrics to connect portfolio health to provisioning behavior, especially under expected credit loss regimes (useful context from IFRS 9 evidence) [5].
- Concentration and wrong-way risk overlays.

5.2 Market risk

Market risk measurement includes:

- VaR/Expected Shortfall for short horizons.
- Stress metrics for tail events.
- Sensitivities (DV01, CS01) and basis exposures to support hedging decisions.

5.3 Liquidity and funding risk

Liquidity risk is operationalized through:

- Survival horizons under stress.
- Cash-flow mismatch ladders.
- Collateral availability under haircut stress.
- Concentration of funding sources.

5.4 Operational, conduct, and resilience risk

Operational risk includes loss event data, key risk indicators (KRIs), scenario analysis, and control testing. Under IRMM, operational resilience metrics (RTO/RPO, outage frequency, cyber readiness) are aligned with appetite triggers and business continuity actions.

5.5 Model risk as a first-class risk

As institutions increasingly rely on models, errors can become systemic. IRMM requires:

- Model inventory and tiering (materiality).
- Independent validation and performance monitoring.
- Change control and monitoring of drift.

5.6 Aggregation: multiple views, one storyline

IRMM produces two consistent aggregation views:

- **Regulatory view:** aligned to reporting and capital requirements.
- **Economic view:** management's best estimate of risk-adjusted value and capital usage. Integration is achieved via scenario narratives and consistent data, not by forcing a single scalar risk number.

Table 5. Measurement toolkit by risk type (IRMM)

Risk type	Core metrics	Forward-looking tool	Decision linkage
Credit	PD/LGD/EAD, NPL, coverage	Portfolio stress + migration	Pricing, limits, collections strategy
Market	ES/VaR, sensitivities	Macro + idiosyncratic shocks	Hedging, inventory limits
Liquidity	LCR/NSFR, survival horizon	Funding run + collateral stress	CFP triggers, asset sales
Operational	Losses, KRIs, control tests	Scenario analysis + resilience tests	Control remediation, service continuity
Model	Validation findings, drift	Monitoring + challenger models	Model approvals, usage limits

6. Technology, Data, and Operating Cadence

6.1 Data governance and lineage

Integration fails if data cannot be reconciled across risk, finance, and treasury. IRMM adopts strong data governance practices with a bank-specific action plan approach that connects master data management and compliance needs for effective risk data management and reporting [7]. Practically, this means consistent counterparty identifiers, product hierarchies, and a reconciled exposure measure across systems.

6.2 Control loop and cadence

IRMM runs on a cadence:

- Daily: limit monitoring, liquidity watch, market exposures, key KRIs.
- Weekly: concentration watchlist, model drift checks, operational incident review.
- Monthly: risk appetite dashboard review with actions.
- Quarterly: scenario refresh, capital planning alignment, appetite recalibration.
- Annual: ICAAP-style holistic review (where applicable), deep model revalidation, severe stress testing.

Table 6. Cadence and governance rhythm

Frequency	Forum	Primary outputs	Typical actions
Daily	Treasury + market risk	Liquidity/market dashboard	Adjust funding/hedges
Weekly	CRO ops review	KRIs, incidents, watchlists	Remediate controls
Monthly	Management risk committee	Appetite status + breaches	Portfolio actions, limit changes
Quarterly	Board risk committee	Scenario results, trends	Strategy adjustments, capital buffers
Annual	Enterprise risk review	Model inventory + severe stress	Policy refresh, investment plan

7. Implementation Roadmap

IRMM is implementable in phases to avoid “big bang” failures:

Phase 1: Foundation (0–3 months)

- Define unified risk taxonomy and data dictionary.
- Establish governance: risk committees, RACI, escalation matrix.

- Create model inventory and minimum validation standards.

Phase 2: Integration (3–9 months)

- Build scenario library and standard stress testing templates.
- Integrate finance–risk–treasury data for a reconciled exposure measure.
- Implement appetite dashboard with triggers and playbooks.

Phase 3: Optimization (9–18 months)

- Automate monitoring, add early-warning indicators.
- Expand to business lines and products, embed into pricing and approvals.
- Mature model risk monitoring and periodic challenger models.

Table 7. Roadmap with success metrics

Phase	Key deliverables	Success metric
Foundation	Taxonomy, governance, model inventory	Fewer definition disputes; clear owners
Integration	Scenario engine, integrated dashboards	Faster escalation; consistent risk view
Optimization	Automation + embedded gates	Reduced repeated breaches; better recovery time

8. Comparative Analysis

IRMM should be compared against common approaches not as a replacement for standards, but as a practical operating model that makes them executable.

8.1 Compared to “silo risk management”

Silo models often provide depth within each risk type, but weak cross-risk aggregation and fragmented decision-making.

8.2 Compared to ERM as commonly implemented

ERM can degrade into documentation if it lacks scenario aggregation, data lineage, and decision rights. Evidence suggests that effectiveness (not merely existence) matters for outcomes [3], and banking evidence links stronger ERM to lower default risk [2].

8.3 Compared to lines-of-defense interpretations

IRMM operationalizes updated thinking on the lines model [8] and extends it in a way consistent with financial institution realities, where external audit and regulators effectively act as additional constraints and feedback mechanisms [9].

8.4 Compared to stress-test-only integration

Stress tests alone can become annual compliance exercises. IRMM makes stress testing part of a continuous steering loop, using simulation-based logic that can estimate fragility and default dynamics [6].

Table 8. Comparative matrix (IRMM vs common approaches)

Criterion	Silo RM	“Typical” ERM	Stress-test centric	IRMM (proposed)
Cross-risk integration	Low	Medium (often conceptual)	Medium (scenario-only)	High (scenario + data + decision rights)
Data consistency	Fragmented	Variable	Variable	Governed exposure + lineage
Actionability	Limit-based per risk	Sometimes report-heavy	Cyclical	Trigger-based playbooks
Board visibility	Partial	High but may be abstract	High during cycles	High and operational
Model risk integration	Often separate	Often separate	Partial	Embedded in business approvals
Speed in crisis	Slower	Variable	Depends	Designed for rapid escalation/actions

9. Discussion, Limitations, and Future Research

IRMM’s core claim is not that integration creates perfect prediction, but that it creates **faster, more consistent decisions under uncertainty**. By linking appetite to actions and using scenario aggregation as the integration backbone, it reduces the probability that risks accumulate unnoticed across silos.

Limitations:

- Implementation depends on data quality and governance maturity.
- Scenario design risk: poor scenarios can create false confidence.
- Organizational resistance: business units may perceive integration as loss of autonomy.
- Quantification challenges: operational and conduct risks remain harder to model.

Future research directions:

- Empirical evaluation of IRMM adoption: does it reduce tail losses or funding stress frequency?
- Integration of climate/ESG risk into balance-sheet scenario engines while maintaining auditability.
- Measuring the effect of model risk governance maturity on financial stability outcomes.

Table 9. Limitations and mitigation

Limitation	Risk	Mitigation in IRMM
Weak data lineage	Inconsistent reports	MDM + governance action plan [7]
Scenario misuse	False comfort	Scenario governance + backtesting
Cultural pushback	Slow adoption	Clear decision rights + incentives
Model overreliance	Hidden errors	Inventory, validation, drift checks

10. Conclusion

Financial institutions need risk management models that reflect the reality of interconnected risks and rapid transmission channels. The proposed **Integrated Risk Management Model (IRMM)** provides a practical blueprint that unifies governance, data, analytics, and execution. It draws support from evidence that stronger ERM

implementation is associated with lower default risk in banking [2] and that structurally strong risk committees strengthen ERM's performance impact [3]. IRMM's distinctive contribution is operational integration: scenario-driven aggregation tied to risk appetite triggers and clear decision rights, supported by strong data governance capabilities [7] and clarified accountability structures [8], [9]. For institutions seeking resilience, IRMM offers a step-by-step path from fragmented reporting to decision-grade, forward-looking risk steering.

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