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Evolution of Data Governance Architecture in State Banking Supervision Systems

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Abstract

The article explores the evolution of data governance architecture in state banking supervision systems amid digital finance, expanding risk interdependence, and rising informational density. The article aims to explain how data governance has become central to supervisory capacity and how its architecture shapes the production of prudential knowledge. The topic is relevant because banking supervision now depends on data quality, traceability, semantic consistency, interoperability, and auditability across digitized supervisory processes. The study's novelty lies in treating data governance architecture as an institutional and epistemic infrastructure of public supervision, rather than as a technical reporting layer. The article shows that the historical transition from fragmented reporting and paper-based control to standardized repositories, integrated platforms, and SupTech-supported analytics has changed the logic of supervisory observation and intervention. The main findings indicate that unified data models, metadata regimes, validation rules, lineage records, stewardship roles, and access controls strengthen supervisory comparability, improve risk detection, and support earlier corrective action. The article will be useful for researchers, financial regulators, central bank specialists, and experts in supervisory technology.

Keywords: *Data Governance, Banking Supervision, SupTech, Supervisory Architecture, Prudential Regulation.*

INTRODUCTION

The architecture of data governance has become a central issue in state banking supervision because supervisory capacity now depends on the quality, granularity, traceability, and institutional usability of data flows produced inside a digitized financial system. Financial supervisors face a wider risk surface shaped by platform finance, API-based service provision, cyber exposure, climate-related disclosure demands, and model-driven banking operations, which places pressure on legacy reporting regimes built for slower supervisory cycles and thinner information layers. A recent BIS study based on survey data from 112 financial authorities across 97 countries shows that institution-wide strategies for digital transformation, data governance, and SupTech are associated with a markedly larger stock of supervisory applications, with authorities that use such strategies deploying, on average, about 20 additional applications (Gambacorta et al., 2025). The same study links weak adoption to outdated IT systems, skill shortages, and data-security concerns, which makes governance architecture a structural condition of supervisory modernization rather than a technical side topic.

Supervisory relevance also follows from the empirical record on oversight itself. Evidence from a natural experiment in U.S. banking shows that a reduction in supervisory and examination capacity increased risky lending, accelerated asset growth, raised reliance on lower-quality capital, and increased the probability of bank failure (Kandrac & Schlusche, 2020). That finding gives the data layer a direct prudential meaning because supervision loses force when its informational base weakens. This problem acquires sharper contours in digital markets, where technological asymmetry between supervised institutions and public authorities can widen informational gaps and weaken timely intervention. Research on SupTech frames this asymmetry as a systemic vulnerability that persists when supervisory technology fails to keep pace with market infrastructure (Zeranski & Sancak, 2021).

In this context, data governance matters for state banking supervision because it organizes the full chain through which supervisory facts are produced, validated, interpreted, and translated into prudential action. Its significance extends beyond data storage and reporting templates. It includes semantic consistency across datasets, ownership rules,

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metadata standards, lineage, access control, and auditability of analytical outputs. Traceability and lineage have also recently been discussed in work exploring data quality in ML development pipelines, as they are highly desirable for regulatory purposes to help interpret and audit how a model's predictions were generated (Priestley et al., 2023).

These features are particularly relevant for supervisory systems that include anomaly detection, early warning, and model-assisted inspection tools. The prudential value of such architecture is visible in new evidence from Brazil, where SupTech-triggered supervisory events led treated banks to increase reported non-performing loans and expected-loss provisions by about 20%, while improving the quality of regulatory risk reporting without damaging financial soundness (Gambacorta et al., 2025). This result suggests that stronger data governance equips the state with a denser informational interface for risk discovery and earlier corrective action. For that reason, the evolution of data governance architecture should be studied as an institutional transformation within public supervision. It changes the way supervisory authorities observe banks, classify vulnerabilities, and construct credible intervention under conditions of informational abundance and technological complexity.

MATERIALS AND METHODOLOGY

The study is based on the analysis of 10 sources, including journal articles and a BIS working paper on data governance, SupTech, machine learning, and banking supervision. The materials were selected for their relevance to the institutional and technical transformation of supervisory systems. The theoretical basis includes studies that define data governance through rules, roles, standards, and accountability mechanisms in complex data environments (Buttow & Weerts, 2023; Bernardo et al., 2024). The supervisory context was examined through research showing that digital transformation strategies and data governance frameworks expand supervisory capacity, while weak supervisory capability increases bank risk and failure probability (Gambacorta et al., 2025; Kandrac & Schlusche, 2020).

The methodology combines conceptual analysis and comparative reading of the literature. The analysis focused on core elements of governance architecture, including metadata, lineage, validation, stewardship, and auditability, as well as on the transition from fragmented reporting systems to integrated and model-assisted supervisory infrastructures (Priestley et al., 2023; Dziawgo, 2021; Guerra et al., 2022). This approach enabled examination of the evolution of data governance architecture in state banking supervision as an institutional change affecting the production and use of supervisory knowledge (Guerra & Castelli, 2021).

RESULTS AND DISCUSSION

Data governance defines the institutional order through which supervisory information is produced, classified, shared, protected, and converted into regulatory knowledge. In recent research, data governance is treated as a coordinated system of rights, responsibilities, technical arrangements, and organizational rules that shapes access to data, conditions of reuse, and the distribution of value and control across actors (Buttow & Weerts, 2023). The same line of research shows that the concept has moved beyond a narrow information-management frame and now includes power relations, accountability, and legally embedded control over data flows. A systematic review of the field identifies recurring architectural components such as data quality rules, stewardship roles, metadata management, lifecycle control, security, and compliance mechanisms, which together form the operational grammar of governance architectures (Bernardo et al., 2024).

In banking supervision, this definition has a distinct prudential meaning, as supervisory data are used to assess capital adequacy, liquidity conditions, asset quality, governance failures, and the transmission channels of systemic stress. Under these conditions, data governance functions as an epistemic infrastructure of supervision. It structures what the authority can observe, how it can compare institutions, and which signals can be treated as credible inputs for intervention.

The architecture of data governance within a supervisory authority comprises a set of interdependent elements that maintain semantic coherence across large reporting systems. These elements include common data models, reference and master data, metadata repositories, validation rules, access controls, lineage records, audit trails, stewardship assignments, and escalation procedures for defects and inconsistencies. Likewise, a new survey of data quality requirements for ML pipelines finds that traceability, provenance and stage-wise quality controls are particularly valuable where models contribute to legally regulated decisions and require auditability across the data pipeline (Priestley et al., 2023). The findings particularly apply to state banking supervision when its legal, confidentiality, procedural and coordination requirements are not directly comparable to those of corporate data governance. RegTech SupTech research frequently describes this public-sector context as a data-technology-regulation nexus wherein the supervisory authorities can monitor solvency, liquidity, reporting quality and conduct risks with shorter feedback cycles due to the adoption of data infrastructures that allow for better understanding and enforcement of rules (Grassi and Lanfranchi 2022).

For the supervisory use case, this interconnectivity of microprudential, macroprudential, and enforcement functions gives particular importance to standardization and institutional ownership of definitions. A review of machine learning in banking supervision reaches a similar conclusion and links the value of new analytical tools to the availability of structured supervisory datasets and to the consistency

of risk taxonomies used by central banks and prudential agencies (Guerra & Castelli, 2021).

The adoption of this architecture is the culmination of a long history of banking supervision moving from a document-centered model to a data-centric model. The old model was characterized by paper reports, spreadsheets, delayed data aggregation, and databases with siloed supervisory data. Quality checks in the end reporting cycle were complemented by an ex post reconciliation process performed by analysts to improve comparability between the banks. The next evolution of reporting processes included centralizing and standardizing the processes through common templates, machine-readable formats, taxonomies and repositories for storing and reusing data. An analysis of SupTech adoption in bank supervision based on Austria's AuRep model showed that converging submission formats, rather than fragmented reporting frequencies and aggregation levels, may lower reporting frictions and allow for improved data collection architectures (Dziawgo, 2021).

The move toward digital platforms and integrated data warehouses then widened the supervisory field by linking quantitative reporting with inspection outputs, market data, and external information sources. Current SupTech development extends this trajectory through automated anomaly detection, early warning systems, and model-assisted supervisory assessment. Earlier findings of an empirical Portuguese study, using supervisory data for 2014-2021, show that machine-learning models can replicate elements of supervisory risk analysis and form part of an early-warning model for the supervisory review process (Guerra et al., 2022). The picture from the BIS survey shows that suptech stock for which there is formal governance architecture and data strategies is now much larger. Governance architecture has become a relevant feature of state supervision, not merely a support layer for reporting routines (Gambacorta et al., 2025). Core elements and evolution of data governance in banking supervision are illustrated in Table 1.

Table 1. Core elements and evolution of data governance in banking supervision

Dimension	Main content	Supervisory relevance
Governance definition	System of rules, roles, controls, and technical arrangements for managing data	Determines how supervisory data are accessed, reused, protected, and governed
Core architecture	Data models, reference data, metadata, validation, access control, lineage, audit trails, stewardship	Maintains consistency, traceability, and accountability across supervisory processes
Supervisory function	Supports observation, comparison, and risk assessment across institutions	Turns data into credible inputs for prudential intervention
Interoperability requirement	Common definitions and structured datasets across supervisory functions	Enables coordination between microprudential, macroprudential, and enforcement work
Historical development	From paper reports and fragmented databases to standardized repositories and digital platforms	Expands supervisory capacity, speed, and analytical integration
Current trajectory	SupTech tools, anomaly detection, early warning systems, model-assisted assessment	Makes governance architecture a foundation of data-centric supervision

The contemporary architecture of data governance in state banking supervision systems rests on the construction of a unified data model that aligns supervisory concepts across reporting, inspection, risk assessment, and enforcement. Such a model defines the meaning of core entities, including institution, exposure, capital component, liquidity position, related party, breach, and corrective measure, within a single semantic space. This common structure reduces ambiguity in the interpretation of supervisory information and supports comparability across banks, time horizons, and regulatory functions. A unified model also changes the logic of supervision itself, because the authority no longer processes isolated forms as detached reporting objects. It works with interconnected data objects that can be traced across multiple supervisory uses. This shift gives the supervisory system a stronger capacity to detect patterns that remain invisible in fragmented reporting environments. It also supports the transition from static observation toward relational analysis of balance-sheet dynamics, governance weaknesses, and risk transmission channels.

Metadata management forms the second layer of this architecture because a supervisory dataset has limited value when its origin, legal status, calculation method, update cycle, and business meaning remain opaque. In a mature governance system, metadata operates as an institutional register of definitions, transformations, ownership, and permitted uses. It preserves continuity when reporting rules change, indicators are recalculated, or several departments rely on the same data asset for different tasks. Data quality control extends this logic into the operational domain. Supervisory authorities need validation rules that test completeness, consistency, plausibility, timeliness, and internal coherence before data enters analytical and decision-making processes. Quality control in this setting is tied to prudential consequences, since distorted values can affect capital assessments, trigger false alerts, or conceal emerging vulnerabilities. Data lineage deepens control by recording the path of each data element from its original submission to the transformed indicator and the supervisory output. This traceable chain strengthens transparency of

origin and creates the evidentiary basis required for internal audit, external review, and legal defensibility of supervisory judgments.

The functioning of this architecture depends on a clear distribution of roles and responsibilities among participants in data governance. Data owners define the business meaning and acceptable use of supervisory data. Data stewards maintain standards, resolve quality defects, and monitor consistency across domains. Technical teams manage storage, access, integration, and protection. Supervisory analysts translate governed data into risk signals and institutional assessments. Senior governance bodies arbitrate conflicts between speed, access, confidentiality, and control. These roles become increasingly important as analytical and supervisory instruments are integrated into shared digital environments. Contemporary supervisory platforms combine reporting data, examination findings, market indicators, early-warning models, and visualization tools within a single architecture of use. This integration allows the authority to move from retrospective compilation toward continuous supervisory intelligence. It also raises the threshold for governance discipline, since analytical power without control over meaning, provenance, and accountability can produce fragile conclusions. The modern architecture of data governance appears as a constitutional layer of state banking supervision. It defines how knowledge is formed inside the supervisory institution and how that knowledge becomes a basis for intervention. Contemporary data governance architecture in state banking supervision is illustrated in Figure 1.

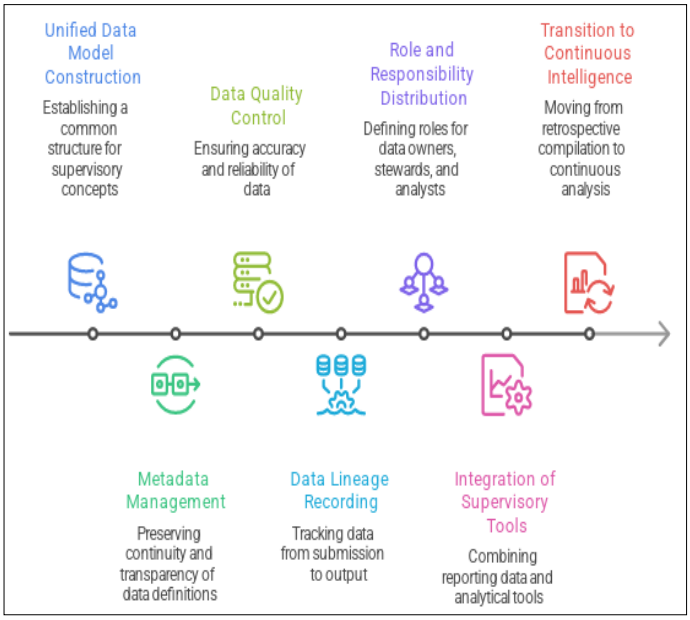

Fig. 1. Contemporary Data Governance Architecture in State Banking Supervision

An illustrative result of this evolution can be observed in the banking supervision practices of the New York State Department of Financial Services, where data governance is being developed through a DAMA-DMBOK-informed operating model. Within this setting, supervisory data is treated as a regulated asset that requires defined ownership, stewardship, quality control, access discipline, and traceable use across the full supervisory cycle. This approach supports a formal distribution of responsibilities among Data Owners, Data Stewards, and domain teams, which gives governance a stable institutional form inside a state regulatory body. The practical significance of this model lies in its capacity to connect supervisory reporting, licensing, examination support, and institutional oversight within one governed data environment.

This evolution is also reflected in a set of linked modernization initiatives. The DFS ID portal introduces a unified identity and access layer for regulated entities and reduces fragmentation in filings, applications, payments, and related supervisory interactions. In parallel, the construction of a Snowflake-based Single Source of Truth platform integrates federal datasets, UBPR data, internal systems, and supervisory records into a shared analytical foundation. Additional governance work, including the Check Casher Data Review and the migration from legacy SharePoint infrastructure to a cloud environment, strengthens data quality, rule consistency, document control, and future integration with supervisory analytics. Taken together, these initiatives show how data governance evolves from dispersed administrative handling of information toward a structured supervisory architecture grounded in metadata discipline, lineage, accountability, and audit-ready data use.

The transformation of data governance architecture in state banking supervision systems is driven by a sharp expansion in the volume, variety, and velocity of supervisory data. Banking supervision now draws on regulatory reporting, transactional records, market signals, internal governance disclosures, stress indicators, and external datasets that reflect interdependence between financial institutions and the wider digital economy. This expansion changes the architecture of governance because data can no longer be treated as a passive reporting resource stored for retrospective review. It becomes a moving supervisory environment in which definitions, access rules, validation logic, and interoperability standards must remain stable across heterogeneous sources. The pressure for transformation also comes from the changing nature of banking risk. Credit risk, liquidity stress, operational disruption, cyber incidents, model risk, concentration patterns, and reputational contagion interact through denser channels than in earlier supervisory settings. Such entanglement requires governance structures capable of linking data across institutional boundaries and supervisory domains. Thus, a fragmented architecture limits the state's ability to identify composite vulnerabilities in terms of correlations, timing, and cumulative exposure rather than single indicators.

Timeliness pressures from supervisors only exacerbate these issues, as delays in validating, aggregating and interpreting data weaken any intervention, and may limit the sequence

of prudential interventions that could be employed. This challenge is compounded by the rise of AI-based RegTech and SupTech, which can be used to analyze large datasets, identify anomalies and generate risk signals over shared infrastructure. Such technologies enforce data governance via the requirement for structure, traceability, outputs and stable semantics on data within automated and semi-automated processes that previously demanded the same from humans and their non-machine processes. State banking supervision handles sensitive institutional information whose compromise can damage market confidence, expose strategic vulnerabilities, and weaken public trust in the supervisory order itself. For that reason, contemporary data governance must integrate confidentiality, resilience, identity control, and auditability into the same institutional design that supports analytical depth and supervisory speed. The architecture evolves because supervision has entered an environment in which informational abundance, technological mediation, and security exposure have become inseparable parts of a single regulatory reality. Main drivers of data governance transformation in state banking supervision are summarized in Table 2.

Table 2. Main drivers of data governance transformation in state banking supervision

Driver	Main effect on governance architecture	Supervisory implication
Data expansion	Requires stable standards across larger and more diverse data flows	Harder to maintain coherence and comparability
Risk complexity	Demands linkage across institutions, risks, and supervisory domains	Better detection of composite vulnerabilities
Need for speed	Pressures validation, aggregation, and interpretation processes	Faster intervention and prudential response
AI, RegTech, and SupTech	Require structured, traceable, and semantically consistent data	Support automated analysis and risk signalling
Cybersecurity and data protection	Embed confidentiality, resilience, identity control, and auditability into governance	Protect supervisory trust and sensitive information

The limitations of the current data governance framework in banking supervision can largely be attributed to the inconsistency between institutional ambitions and the inertia of the infrastructure. Many supervisory authorities are still using legacy IT systems for periodic reporting and data silos which limit data interoperability between the different supervisory functions and data flows. This technical burden can be exacerbated by a fragmented regulatory structure, with multiple legal routes that govern reporting requirements, confidentiality obligations, inspection regimes and digital regulations, which can create conceptual gaps within the supervisory framework. Human capital is another constraint, as the knowledge from a variety of disciplines, including banking supervision, information structure, data engineering, cybersecurity and analytical modeling, is required to manage supervisory data. Organizational design adds a further layer of difficulty because centralization promises consistency, common standards, and institutional control, while supervisory practice still needs room for domain-specific interpretation, local risk knowledge, and adaptive responses to emerging threats.

The spread of algorithmic tools introduces legal and ethical pressure into this already dense environment, as automated classification, anomaly detection, and model-assisted judgment raise questions about explainability, accountability, procedural fairness, and the boundaries of delegated machine reasoning in public authority. The future architecture of supervisory data governance is likely to move toward supervisory regimes that operate on near-real-time information, continuous validation, and shorter feedback loops between reporting, analysis, and intervention. Such a shift will require federated governance models that coexist with distributed stewardship across functional domains, supporting common principles, shared semantics, and unified controls. It will also require stronger international harmonization of supervisory data, since banking risks move across jurisdictions through capital flows, group structures, outsourced infrastructures, and digital platforms that resist narrow domestic classification. In this setting, governance by design emerges as a governing principle of the next supervisory architecture. It embeds data quality, legal traceability, security, interoperability, and audit logic into the structure of systems at the moment of their creation.

CONCLUSION

The evolution of data governance architecture in state banking supervision systems indicates a deep institutional reconfiguration of supervisory capacity under conditions of digital finance, expanded risk interdependence, and rising informational density. Across the examined material, data governance appears as the epistemic and operational infrastructure through which supervisory facts are defined, validated, traced, shared, and converted into prudential judgment. Its architecture brings together unified data models, metadata regimes, validation rules, lineage records, stewardship roles, access controls, and audit trails within a single supervisory environment. This architecture strengthens semantic coherence across reporting, inspection, risk assessment, and enforcement, while increasing the state's ability to identify vulnerabilities, compare institutions, and support earlier intervention. The article shows that stronger

governance frameworks are associated with wider diffusion of SupTech, better reporting quality, and greater supervisory action effectiveness, suggesting that governance, and data governance, have become an essential part of the modern public oversight of banking systems.

The evolution from paper-based reporting and multiple disconnected and ad-hoc databases, towards recognized repositories, integrated databases and model-assisted supervision, shows that data governance has a constitutional place in supervisory design. This trajectory is driven by the expansion of data sources, the growing complexity of banking risks, the demand for shorter supervisory cycles, the spread of AI, RegTech, and SupTech, and the centrality of cybersecurity and data protection. At the same time, the article shows that legacy infrastructures, fragmented legal frameworks, skill deficits, and the juridical demands attached to algorithmic tools continue to constrain this transition. For that reason, the future of state banking supervision depends on governance architectures capable of sustaining interoperability, legal traceability, resilience, and shared semantic control across distributed supervisory functions and cross-border financial structures.

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