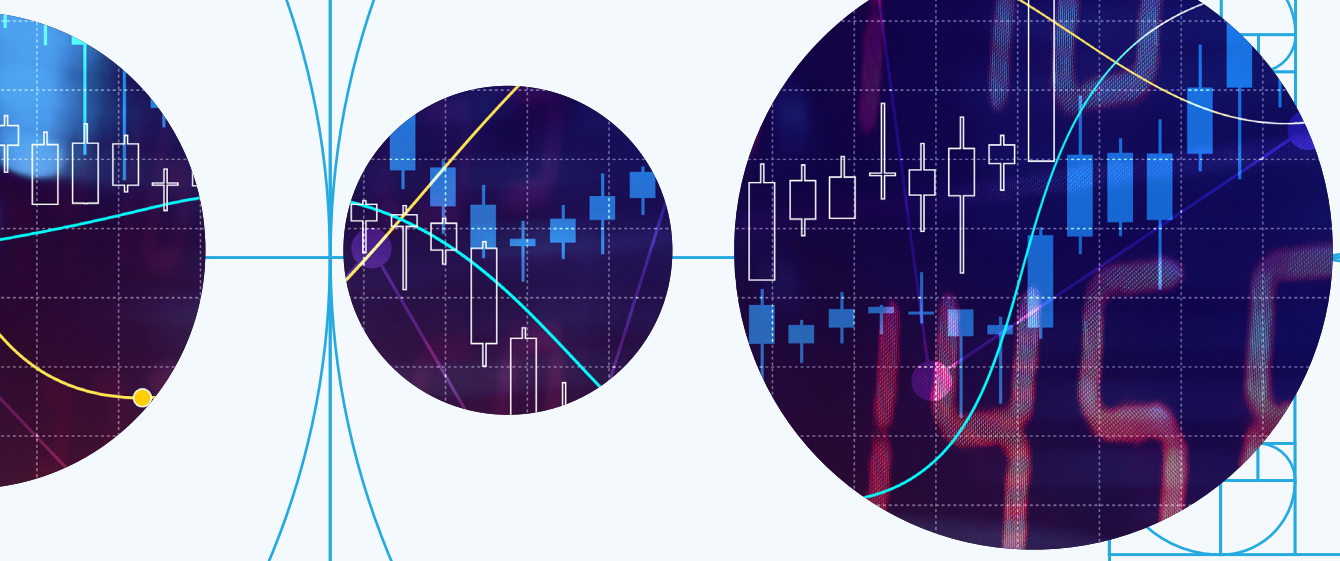
Market Quadrants

ALM Technology Systems, 2021

Market and Vendor Landscape



Chartis

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- Credit risk.
- Operational risk and governance, risk and compliance (GRC).
- Market risk.
- Asset and liability management (ALM) and liquidity risk.
- Energy and commodity trading risk.
- Financial crime including trader surveillance, anti-fraud and anti-money laundering.
- Cyber risk management.
- Insurance risk.
- Regulatory requirements including Basel 2 and 3, Dodd-Frank, MiFID II and Solvency II.

Chartis is solely focused on risk and compliance technology, which gives it a significant advantage over generic market analysts.

The firm has brought together a leading team of analysts and advisors from the risk management and financial services industries. This team has hands-on experience of implementing and developing risk management systems and programs for Fortune 500 companies and leading consulting houses.

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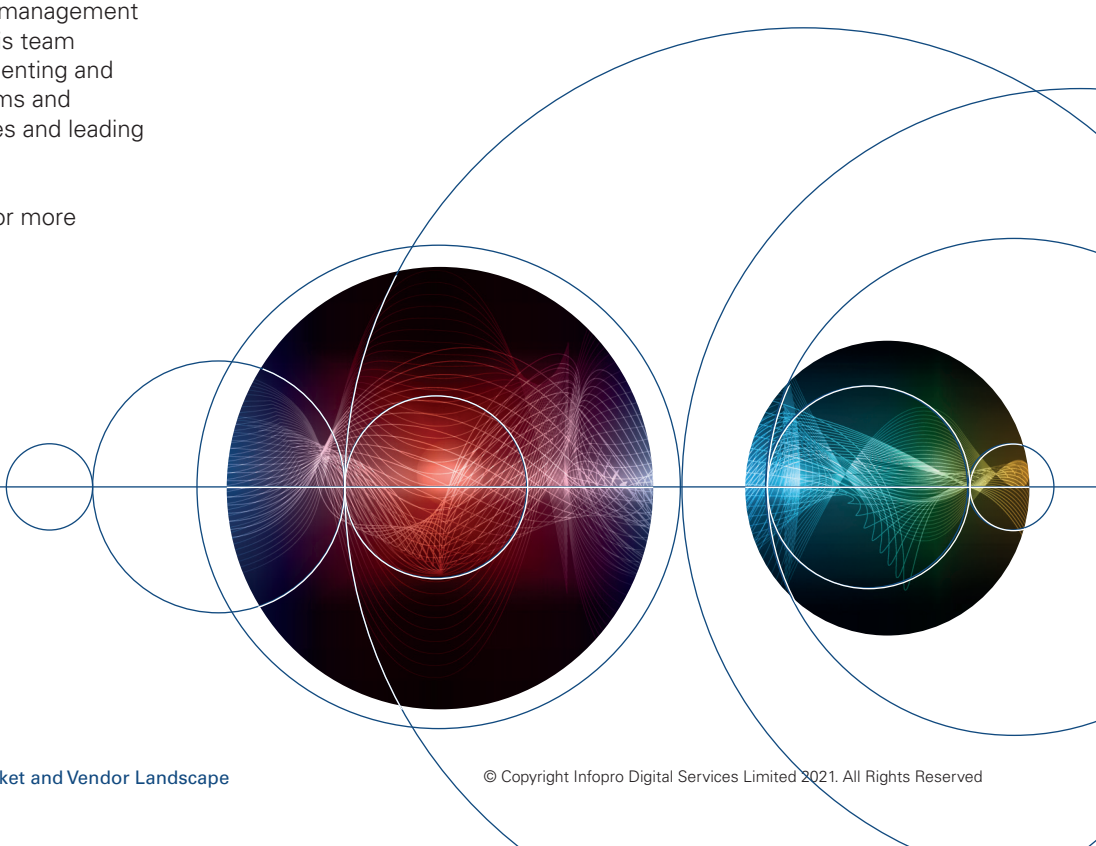


Table of contents

List of figures and tables

1. Executive summary

Toward a new standard: a dynamic story of integration and differentiation

Asset and liability management (ALM) is the process of managing and optimizing the assets and cash flows that financial institutions (FIs) use to meet their obligations. This process of management and optimization covers a spectrum of market risks and their sprawling interrelationships, as well as key product and customer dynamics. The process and systems involved in ALM are evolving: regulations, processes of integration and emerging industry standards are all converging to create a new complex and maturing ALM framework.

FIs' systems have evolved in response to several forces shaping modern ALM practices and heightening their complexity. Confronted with diverse regulatory challenges and sometimes competing standards and rules – alongside market volatility and the availability of new technology resources – FIs are working toward a new ALM standard.

As a technology and analytical revolution sweeps the banking book[1], old challenges and issues are also intensifying, and new ones are emerging. As expected credit loss (ECL) accountancy standards usher in a new wave of advanced credit models, institutions in Europe, the Middle East and Africa (EMEA) must contend with a lack of readily available modeling data that they can use to enrich them. Likewise, while sophisticated behavioral models are powering better informed cash-flow projections based on customer behavior, the machine learning (ML) techniques that underpin them bring their own issues, largely around 'explainability'. On the operational side, banks still tend to be lumbered with a patchwork of legacy systems, established to manage different aspects of the balance sheet.

Industry and regulatory standards are pushing FIs to integrate their ALM operations and unify their ALM policies under a comprehensive internal strategy. But integrating the multiplicity of departments, roles and responsibilities involved in ALM is not a simple task. In addition, this integration coincides with the cross-pollination of methodologies and practices between firms in the banking book, the trading book and the insurance sector. Where necessary, however, it is vital that, from an analytical perspective, the different segments of ALM remain distinct. To improve the focus and rigor of the analytics being developed, they must exist within the boundaries of their respective segments.

The Chartis view is that ALM is a holistic process, and the story one of integration and differentiation running in parallel. From the perspective of enterprise risk management, the integration of regulatory requirements and internal risk management is vital. Because ALM crosses and covers multiple departments and business lines, without effective integration the overall ALM process can be ineffective.

But first and foremost ALM is an analytical activity and, increasingly, a *quantitative* process. Crucially, however, the tools and practices FIs use in distinct segments of their ALM systems should be differentiated so firms can develop methodological clarity and focused analytical rigor across their ALM systems.

In this report we discuss the growing importance and prevalence of an integrated approach to ALM, as well as the diversity that exists within ALM requirements. Our focus will be the often sophisticated analytics that ALM processes entail; we also consider how regulatory forces converge with one another and interlock with shifting industry standards. While we concentrate on the banking sector, we also contextualize our analysis within wider insurance and capital-market trends. We also consider how the established ALM market is populated by numerous vendors – although major dynamic shifts are happening in the market as vendors vie to compete in the context of new industry standards. Many firms have expanded to enable them to specialize in core areas and invest in their analytics capabilities. In short, this is a market in the throes of evolution, and as such is one that merits much closer study.

This report uses Chartis' RiskTech Quadrant© to explain the structure of the market. The RiskTech Quadrant© uses a comprehensive methodology of in-depth independent research and a clear scoring system to explain which technology solutions meet an organization's needs. The RiskTech Quadrant© does not simply describe one technology solution as the best risk-management solution; rather, it has a sophisticated ranking methodology to explain which solutions would be best for buyers, depending on their implementation strategies.

[1] *For more information, see the Chartis report 'Technology Solutions for Credit Risk 2.0: Credit Risk Analytics, 2020'.*

This report covers the following providers of ALM technology systems: ALM First, AxiomSL, The Baker Group, FERNBACH, FIMAC Solutions, Finastra, FIS, Fiserv, InfrasoftTech, Intellect Design, Kamakura, Mirai, Moody's Analytics (including the recently acquired ZMFS), MORS Software, Numerical Technologies, Oracle, Prometeia, QRM, SS&C Algorithmics, Surya, THC (Thomas Ho Company), Wolters Kluwer, and zeb.

We aim to provide as comprehensive a view of the vendor landscape as possible within the context of our research. Note, however, that not all vendors we approached provided adequate information for our analysis, and some declined to participate in this research.

2. Market landscape

Context: what is ALM and what is shaping it?

ALM is a broad area characterized by ambiguous definitions and terminology. Over time, however, the ALM landscape has enjoyed increased specification and a wider understanding of how it operates. We divide the overarching category of 'ALM' into four interrelated and interlinked areas:

- **ALM itself**: the analytical and quantitative framework that characterizes asset and liability management.
- **Funds transfer pricing** (FTP) and profitability analysis, including the construction and use of curves for pricing.
- **Liquidity risk management** (LRM), and specifically that based on Basel reporting requirements.
- **Capital and balance sheet optimization**: optimization engines with embedded scenario and simulation frameworks, as well as business planning and analysis processes.

While their precise nature may vary by institution, ALM processes and systems contain some common core components. In general, ALM refers to projections around the timing and amount of cash flow on a balance sheet, as well as the management of its risks, which include interest rate risk, credit risk and liquidity risk. The core processes and analytics of ALM include behavioral modeling, FTP, cash flow projections, stress testing and reverse stress testing, scenario management, data management, and capital and balance sheet optimization (see Figure 1). To manage these risks and processes, institutions require increasingly sophisticated analytical tools.

Shifting dynamics shaping ALM

Several pressures and dynamics in the financial industry are encouraging evolution and development in the ALM landscape (see Figure 2).

These include market and business dynamics such as interest rate volatility, business resilience, cost pressures and, crucially, regulation.

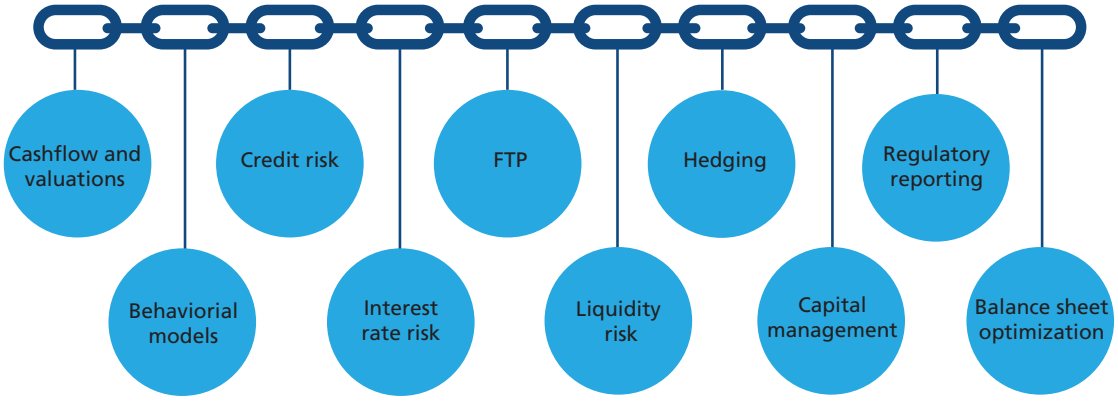
Focus: regulation as a key driver of ALM

Regulatory pressure and the evolution of risk management tools are helping to align the banking book with the more sophisticated techniques already incorporated on the trading book side, and the standardization of ALM methodology in the insurance sector. In the past decade we have seen continued regulatory change covering the entire cross-section of ALM processes and requirements. The three pillars of the Basel Committee on Banking Supervision (BCBS) regulations (see Figure 3), updated most recently with the 2017 Basel IV amendments (for 2023 implementation), act as a benchmark for most global banks' ALM frameworks, covering market risk, credit risk, liquidity ratios and benchmarks, and capital adequacy. Regional supervisory authorities (such as the European Banking Authority [EBA]) are responsible for providing the binding technical standards and reports for the Basel framework.

Accounting standards, ALM and analytics

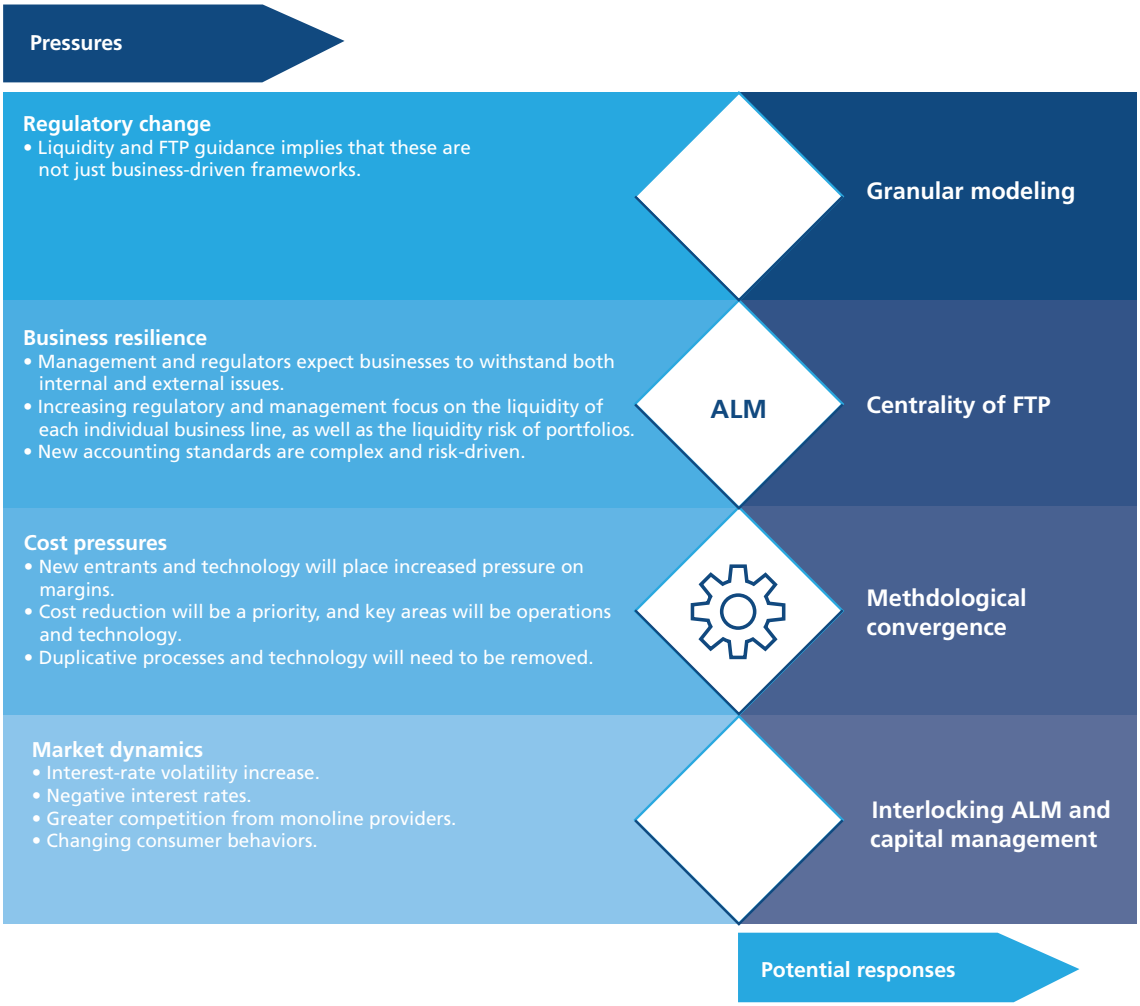
Most global banks will also be subject to several accountancy standards that have come into force in recent years, notably International Financial Reporting Standard (IFRS) 9 and its US counterpart

Figure 1: ALM – interlinked systems and processes



Source: Chartis Research

Figure 2: Shifting dynamics are shaping the ALM landscape

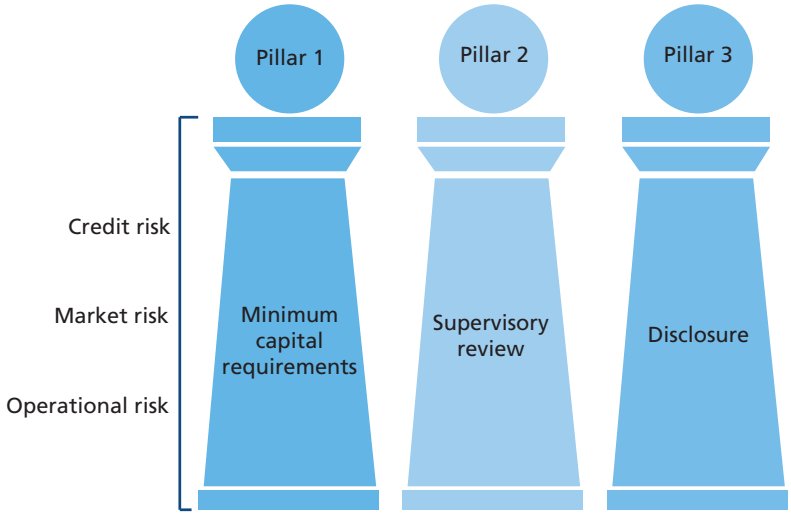


Source: Chartis Research

Current Expected Credit Losses (CECL), which is issued by the Financial Accounting Standards Board (FASB). Both govern the way that banks account for credit loss in their loan portfolios. Under IFRS 9, FIs will have to assess the level of credit risk associated with an asset and then project their expected losses on either a 12-month or a lifetime basis. Under CECL, all loans must be measured as lifetime projections.

IFRS 9 and CECL have prompted an uptake in sophisticated credit analytics and cash-flow modeling among FIs, as impairment calculations become a standard feature of firms' credit modeling. The new suite of credit models catalyzed by IFRS 9 and CECL coincide with the now commonplace requirement of stress testing for banks, and these models can be transferred to support stress-testing frameworks. Both standards have also exposed data challenges, especially for banks complying with IFRS 9 in EMEA, which –

Figure 3: The Basel pillars – providing a benchmark for ALM



Source: Chartis Research

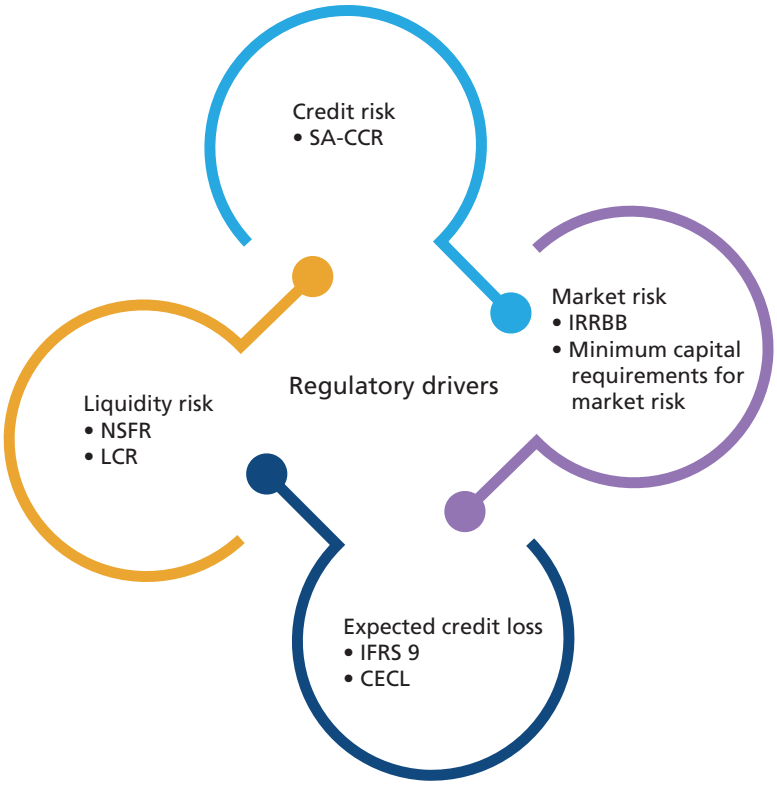
compared to the US – has a relative scarcity of credit data.

IFRS 9 and CECL are also having direct impacts on institutions' ALM strategies. At the product level, new measurement rules can alter how profitability appears on a firm's balance sheet, or may cause increased balance-sheet volatility. As a result, the standards are sharpening FIs' focus on the strategic purpose of different products. Under IFRS 9, FIs must test the business model for each product, to determine how it is measured and reported. IFRS 9 and CECL may also affect how derivatives are used to manage credit exposure and interest-rate risk.

Growing strategic importance

As regulatory forces (see Figure 4) shape industry practices (affecting profits, models and the complexity of ALM), they are pushing banks to assign more strategic importance to their ALM departments. Meanwhile, methodological rigor across the various key segments of ALM is improving. On the operational side, banks are now recognizing the value of ALM for financial performance and capital management, and are starting to coordinate an integrated, interactive ALM process across departments and business units.

Figure 4: Converging regulations affecting ALM



Source: Chartis Research

ALM in action: how, why, what

As a discipline, ALM has evolved largely through its use and practice, as day-to-day challenges and conditions have informed and catalyzed periods of change. Multiple points of convergence and integration are distributed across the ALM value chain, and are combining to create a new emerging standard in ALM – an *integrated approach* underpinned by advanced analytics, with focused methodologies in each segment.

The integration angle

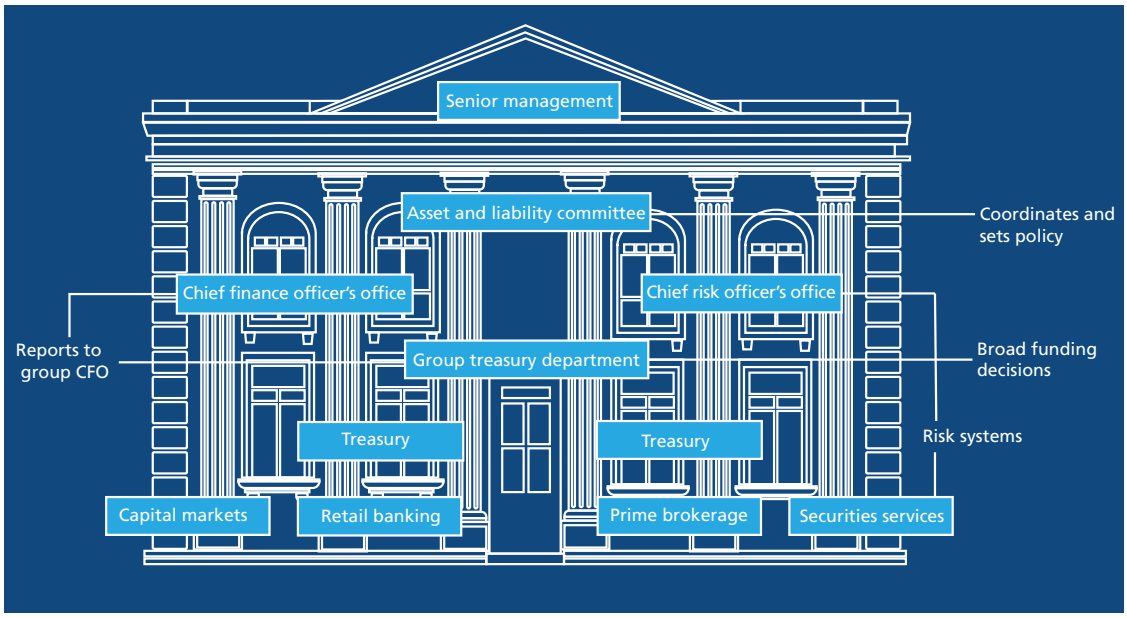
Departmental roles

Generally, the scope of ALM responsibilities is common across different banks; however, the structure and organization of ALM operations varies tremendously across the industry. ALM's scope means that specific institutions' operational needs are highly diverse. The key departments responsible for ALM in a bank are the chief risk officer's (CRO's) office, the chief financial officer's (CFO's) office, and the treasury (see Figure 5). At the highest level in the organization, the asset and liability committee (ALCO) decides the overarching ALM strategy. How the ALCO is integrated into the bank's structure, however, is unique to each institution and its internal strategy and approach, as are how the associated ALM-specific units are integrated into the wider banking business.

Strategic risk management will require coordination across the bank, with cross-discipline integration. To varying extents, market risk, liquidity risk and credit risk will fall under the jurisdiction of the **CRO**, who will be responsible for setting the risk appetite for different risk categories. Large business lines may even have their own CRO's office in charge of lower-level risk-focused decisions.

A bank's size and business model will dictate the size and structure of the **treasury** deparments it has. At lower levels within the bank, business lines may have their own internal treasury department that reports to the group treasury. And while the **CFO**'s office will ultimately be responsible for liquidity, capital management, accounting and reporting, it will depend on input from and coordination with the risk department (as well as the front office and other business units).

Figure 5: Departmental roles and ALM



Source: Chartis Research

However, ALM risk management cannot be neatly compartmentalized into departments, especially in larger and more complex businesses. Conventionally, banks have preferred to employ different teams for different risk types, but regulation and market and industry trends are pushing them to rethink their approaches. That said, combining risk types can be computationally challenging.

Multi-layer convergence

Despite the challenges, tools and processes within FIs are becoming increasingly integrated, and this is contributing to a new developing set of ALM standards. Similarly, across all levels of an FI, products, methodology, regional trends and business lines are converging to form multi-disciplinary perspectives on ALM practices (see Figure 6).

COVID-19 concerns and actions

The profound impacts of the COVID-19 pandemic on the global financial system have fueled market uncertainty and raised questions about how FIs manage their ALM, which straddles multiple risk types and investment strategies. The pandemic has had several varied effects on the ALM landscape, prompting varying degrees of concern from FIs' senior management. More than ever, understanding and predicting customer behavior is now a vital part of ALM. Stress testing and reverse stress testing, meanwhile, as well as joint credit and interest-rate risk analysis, will also come into sharper focus as institutions adapt to the crisis and prepare their future defenses.

To learn the lessons of the crisis effectively, institutions must carefully assess its current impact on their balance sheets, and the impact it will continue to have. The initial direct consequence of the pandemic is to create challenges around cash flow and the risk level of loans, and a significant proportion of loans will have to be categorized as non-performing. Longer-term issues are likely to include persistent low interest rates, adaptations to investment strategies, and the migration of credit. To prepare properly, FIs will have to rely on forecasts that are based on their scenario generation and stress tests. Customer behavior during and in the aftermath of the pandemic will also be a key component in preparing an ALM strategy in the face of COVID-19.

A cross-pollination of ideas

A key theme in Chartis' view of the changing ALM landscape is the effect that a broad cross-pollination of ideas, methodology and tools is having on key technology trends in different industries. As a result of the interplay between the banking book, the trading book and the insurance business, for example, their respective ALM frameworks are evolving, helping to create more mature and enriched responses to the challenges they face (see Figure 7).

Another example of the influence that different industry segments can have on trends in ALM is the emerging ALM framework in the 'shadow banking' sector (which developed as a significant industry segment after the regulations following the 2008 financial crisis). Much of the banking business has become distributed over a wider variety of 'shadow' institutions, which have little experience of running ALM frameworks, especially when periods of volatility or crisis (such as the COVID-19 pandemic) strike. From a product perspective, for example, ALM for monoline providers (of products such as mortgage backed securities [MBSs] and credit default swaps [CDSs]) may seem straightforward – but in fact it can be highly complex.

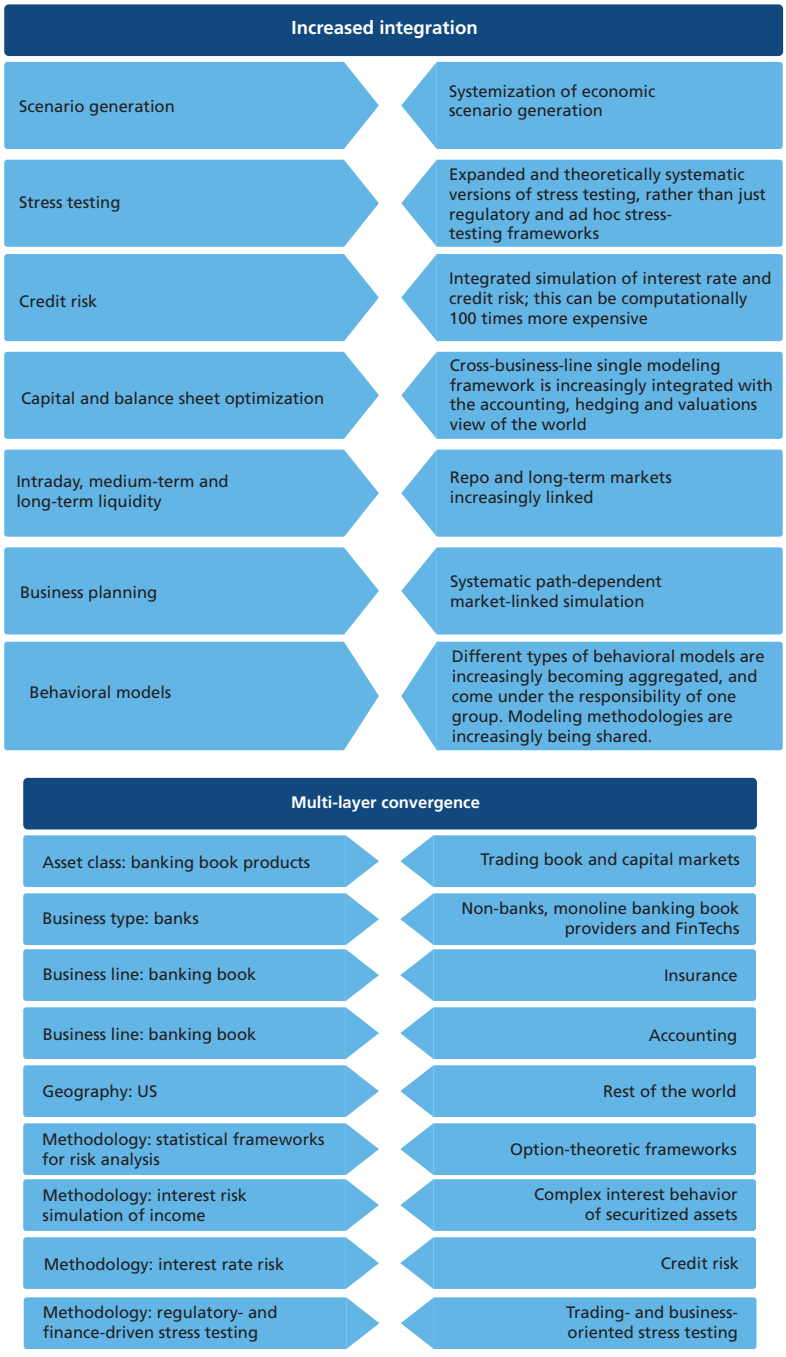
Many monoline providers essentially integrate capital markets and the banking industry. They have a simpler profile on the liability side, with products (such as repurchase agreements and bonds) drawn largely from the capital markets, while firms on the asset side often have a much more conventional banking-book structure. This mismatch in market structure and trade/schedule frequency can lead to the occasional shock, potentially exposing the shadow banking sector to financial meltdown (as exemplified by some of the events of the 2008 crisis).

The key components of ALM

New trends in technology can help FIs strengthen their ALM frameworks and more effectively optimize their balance sheets. The ALM value chain has several steps (see Figure 8), and its various segments rely on different types of technology infrastructure. To track and aggregate all transactions throughout an institution, FIs will need robust data management functionality, while cash-flow modeling and balance sheet optimization require strong analytics management functionality.

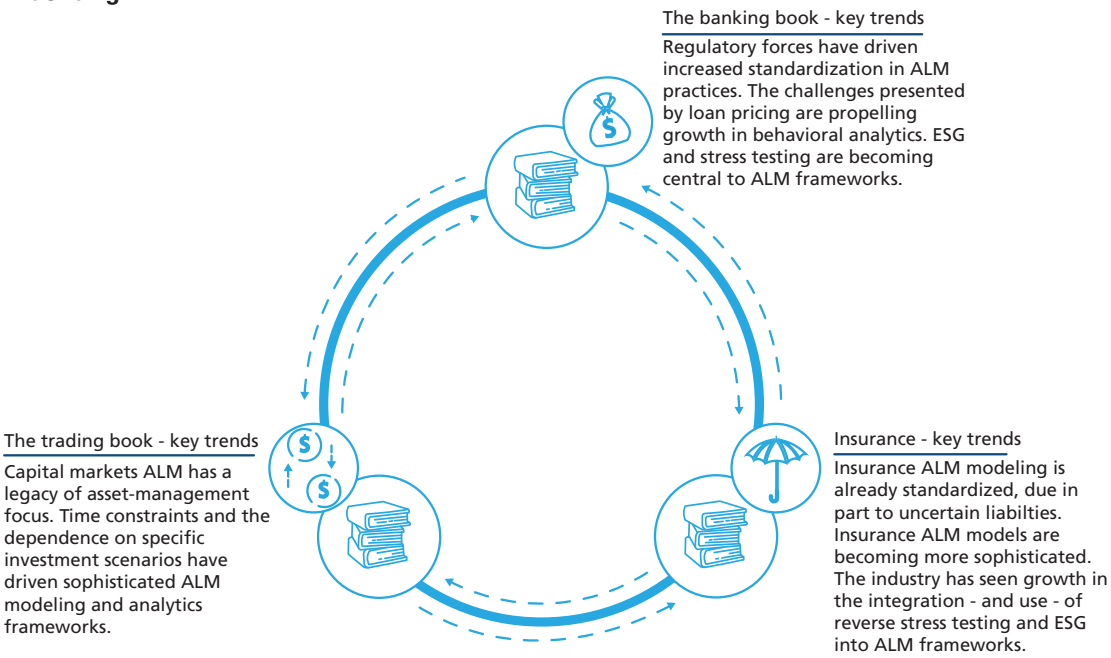
The banking book in particular is experiencing a convergence in the growth of key technology areas (such as stress testing and behavioral modeling) and a methodological standardization. And these dynamics are helping to bring it in line with ALM practices already in the trading book and the insurance industry – both of which are also experiencing a shift in their ALM environments and technology trends.

Figure 6: Multi-layer convergence and increased integration are creating a new ALM standard



Source: Chartis Research

Figure 7: Cross-pollination – how the interplay of banking, trading and insurance approaches is influencing ALM



Source: Chartis Research

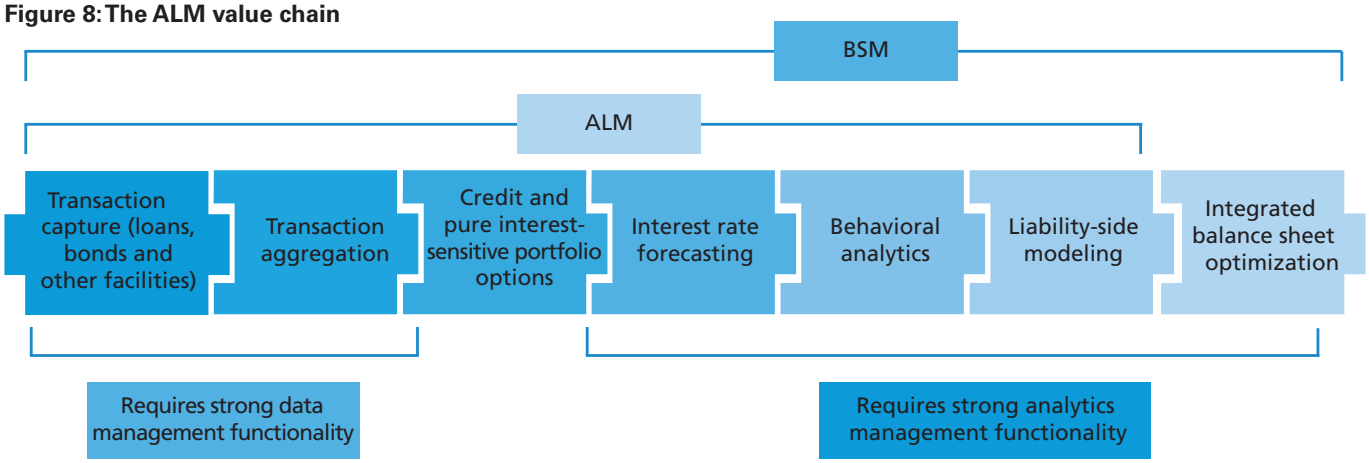
As previously discussed, we have grouped the many mechanisms and techniques within ALM into four distinct subcategories, a split reflected in our view of the vendor market and our scoring:

- ALM (focused risk analytics).
- FTP.
- LRM.
- Capital and balance sheet optimization.

ALM analytics: a quantitative revolution

By tapping into advanced analytical frameworks, banks can improve the sophistication of their business planning and analysis. Effective analytics can enable ALM and treasury managers to identify risks and opportunities and seek the best hedging opportunities and optimization choices. Within ALM the focus on analytics is increasing, due in part to persistent low interest rates and an increased desire among FIs to drive operational profit across the banking industry. Together these drivers are making more sophisticated ALM frameworks commonplace.

Figure 8: The ALM value chain



Source: Chartis Research

The banking book, notably, is experiencing a quantitative revolution, as banks increasingly look to analytical frameworks to provide them with the tools they need to address the end-to-end ALM value chain. Alongside banks' growing demand for more analytical capability is a desire for greater openness in the systems they do implement – banks want to be more able to customize their processes by inserting their own analytics.

In fact, ALM analytics in the banking book are progressing from being previously fragmented sets of tools toward unified frameworks that operate under a more coherent overarching analytical discipline. On the data side, banking-book products are increasingly taking data inputs from capital markets, especially for modeling prepayments and other implied curves (to compare risk and return performance).

Fragmentation is inevitable

Nevertheless, as the new emerging standard of ALM evolves to cover analytics of greater depth and sophistication across the ALM value chain, some fragmentation is inevitable. In the past, it may have been possible to build a single ALM system that could cut across the entire ALM value chain and satisfy the various stakeholders involved. Faced with rising complexity and more sophisticated tools, however, maintaining a focused view of multiple ALM segments in one platform is becoming impractical. (We aim to reflect the fragmentation of the ALM landscape by including several ALM quadrants in our report.)

Within its analytics-focused story, Chartis has identified specific areas of growth, including balance sheet optimization, stress testing and reverse stress testing, and behavioral modeling. These are explored in more detail in the following sections. Other areas of growth include the maturity of FTP technology and the impact of behavioral analytics on cash-flow projections. FTP has come of age, and within FIs there is a strong desire to accurately charge every banking product across all business lines. Behavioral analytics, meanwhile, are proving instrumental when FIs model cash flows that depend on a counterparty's behavior.

Balance sheet and capital optimization

In a climate of greater risk-based capital requirements and diminished returns, balance sheet and capital optimization are critical elements of the ALM value chain, underpinning a bank's ALM strategy. As FIs contend with regulations ranging from capital requirements to interest-rate risk, and navigate the liquidity ratios and capital adequacy frameworks introduced by Basel III, Dodd-Frank and the European Market Infrastructure Regulation (EMIR), they must also maximize their returns and balance risk. With optimization models they can assess the results of different scenario projections on their balance sheets and capital, and use the results to inform their best course of action.

- *Capital management* is not a conventional feature of a bank's core ALM function. But under regulatory pressure, and in a climate of capital shortages, capital management has evolved into an integrated segment of ALM. Capital adequacy and planning are also subject to stress-testing frameworks. These various calculations and outputs all inform an FI's overall capital optimization strategy.

- As a discipline, *balance sheet optimization* in the banking book is broadening, but it is still in an 'early learning' phase. Balance sheet management models in banking are conceptually much simpler than those in insurance and wealth management. In wealth management, standard portfolio optimization and analytics techniques do not cater to the sector's wide variety of business contexts. AI-based optimization techniques using ML and evolutionary programming (EP) are increasingly popular in wealth management.

While firms in the banking book are moving toward more dynamic and frequently employed optimization frameworks, they are still behind their counterparts in other areas of the finance industry. The value of managerial decisions within a regulatory context is a core dynamic of balance sheet optimization processes. With increasingly sophisticated performance analysis, banking book managers can analyze their choices and the effectiveness of their balance sheet decisions. As a result, they are gaining a dynamic insight into how the market and regulations impact their product strategies.

Stress testing and reverse stress testing

Stress testing regimes and frameworks have evolved into a common language with which to assess banks' ability to withstand economic shocks and downturns. They are also important features of assumption testing, and in determining how optionality projections change under various circumstances. In the past, stress testing has been more ad hoc, driven by regulation: either regulators

provided defined tests or banks developed their own internally. Now there is a drive toward more business-oriented stress-testing frameworks that are mathematically sound. The new standard of stress-testing frameworks no longer relies on internally generated conditions, but instead implies the results and data from market and business conditions. To achieve a generalized scenario management system that is formalized and has a set of rules and principles, FIs need a mechanism that links it across all business lines.

While demand for reverse stress testing is growing, it is still relatively young as a cohesive standardized practice – there is still some debate in the industry around its use, and some confusion about how best to employ it. For Chartis, the real value of reverse stress testing is not in simulating extreme events, but rather in pinpointing the more imperceptible effects of particular situations. Reverse stress testing can be very valuable when firms are analyzing highly balanced portfolios and identifying the granular issues that standard stress testing does not highlight.

Behavioral modeling

A longstanding challenge for ALM in the banking book is the issue of *optionality*. Because many factors can influence whether a retail customer chooses to exercise optionality, including interest rate changes, predicting patterns of early withdrawal, prepayment and borrowing is a challenge. But the relationship of interest-rate levels to customer behavior is rarely a strict linear correlation.

Behavioral models are therefore an essential element of ALM. By implementing them, FIs can enable dynamic future cash-flow analyses, which are crucial for estimating future net-interest income under various financial scenarios. As a result, behavioral models are proliferating across the full lifecycle of banking-book assets (see Figure 9), and can increasingly be fed a broad range of data inputs.

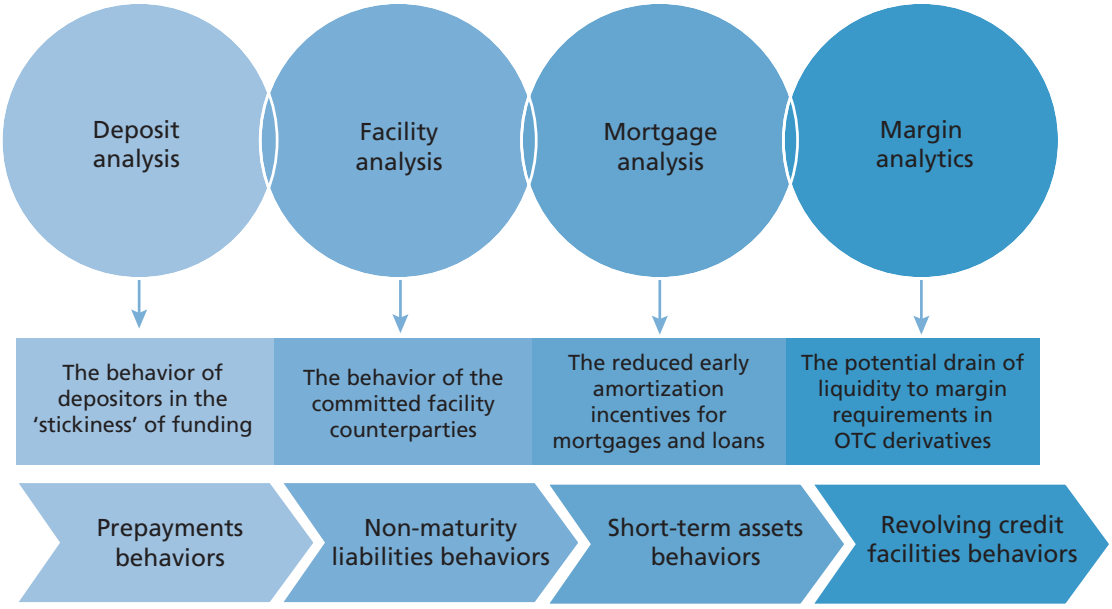
Behavioral models have a role in a broad range of ALM processes (see Figure 10). Nevertheless, while the goal of behavioral models is to help firms predict customer behavior, they can fall foul of regulators' expectations around explainability, which is affecting their wider rollout. Senior managers' ALM strategies must be informed by explainable decision making.

Other key ALM components

Cash-flow forecasting

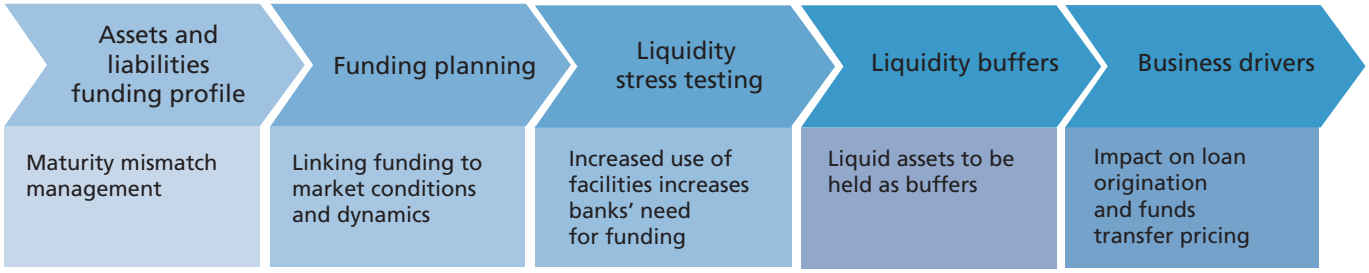
Projecting asset and liability cash flows is a foundational element of ALM – creating these cash-flow structures is an important initial step before optimization and funding processes can take place. These projections are based on the intrinsic uncertainty around the timing and amount of cash inflow or outflow an FI can expect. Cash-flow forecasts rely on complex

Figure 9: Behavioral modeling across the full lifecycle of assets



Source: Chartis Research

Figure 10: Behavioral models have a role in a broad range of processes



Source: Chartis Research

non-linear mathematical models, especially for retail and insurance products. As modeling and analysis become more granular, there has been an accompanying increase in demand for more granular cash-flow models. The challenge for FIs lies in maintaining consistency and scalability for granular, daily cash-flow processing.

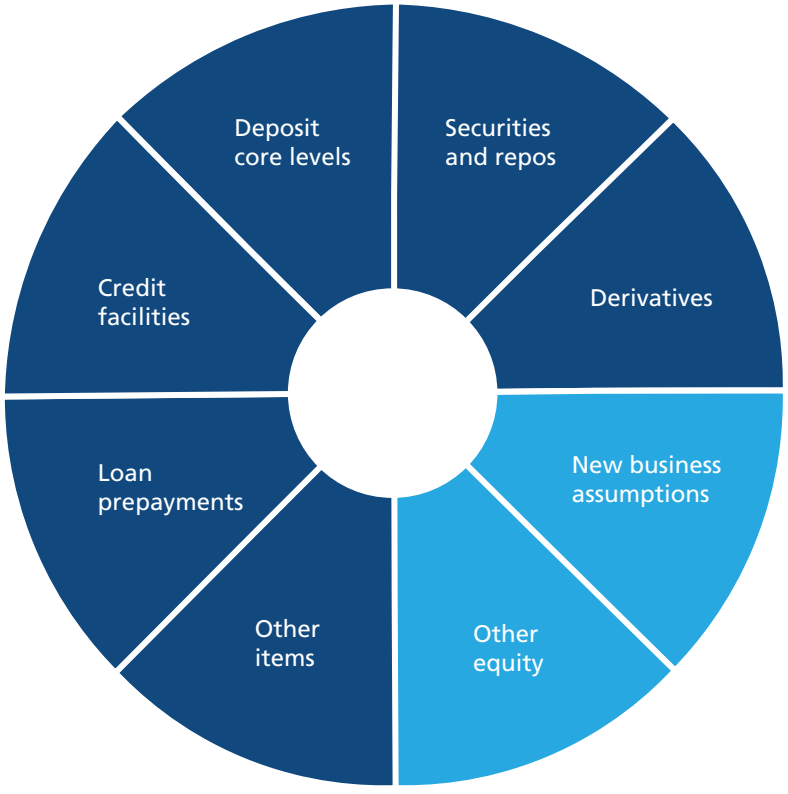
Interest-rate and *behavioral modeling* are core applications in cash-flow modeling (see Figure 11). On the liability side, customer behavior and macroeconomic conditions can alter the amount customers are saving, affecting banks' expectations of the money they will have. On the asset side, meanwhile, embedded optionality can create constituent implied cash flows. Uncertainty around the timing and amount of cash, including funding costs and investment returns, has put pressure on institutions to create efficient and accurate projections. And regulatory considerations, including liquidity and capital adequacy, create additional pressures for banks.

Interest rate risk management – taking center stage

Interest-rate modeling has a long legacy in ALM, but recent regulatory guidance on how FIs should manage the risk arising from interest-rate fluctuations on non-trading book activities has created new challenges for them. A persistently low interest-rate environment has put sustained pressure on banks' margins. Changes in the money and capital market interest rates affect the value of a bank's assets and liabilities, the timing of cash flows, and the effectiveness of hedging strategies.

Market conditions and regulatory compliance are driving the development of modeling techniques and methodology. Complex dynamic cash flow modeling is an advanced method for projecting future cash flows, because it includes potential changes in a firm's balance sheet composition in response to fluctuating interest rate environments. As for regulation, Interest Rate in the Banking Book (IRRBB) is part of the BCBS' capital framework Pillar II. More recently, the EBA issued guidance on IRRBB in 2018 (it came into full effect in 2020), giving banks a new interest-rate framework that includes how they measure, hedge and navigate their interest-rate risk (see Figure 12). Regulatory compliance for IRRBB frameworks is shaped by local supervisory guidance on governance, policies, and measurements and methodologies. Both the European Central Bank (ECB) and the BCBS require banks to measure and report IRRBB using Economic Value of Equity (EVE) and Net Interest Income (NII) under stressed conditions.

Figure 11: Components of cash-flow modeling



Source: Chartis Research

Managing IRRBB is the responsibility of multiple parts of the bank, including the treasury, finance and risk departments, and the board and senior management must develop governance and policies to ensure effective compliance. Business decisions also affect the profit a bank can create by managing IRRBB, so it is vital that IRRBB is leveraged beyond compliance as an opportunity to generate income. Banks will also need to align their IRRBB frameworks with their liquidity management frameworks, including their Net Stable Funding Ratio (NSFR), Liquidity Coverage Ratio (LCR)[2] compliance, and FTP structures.

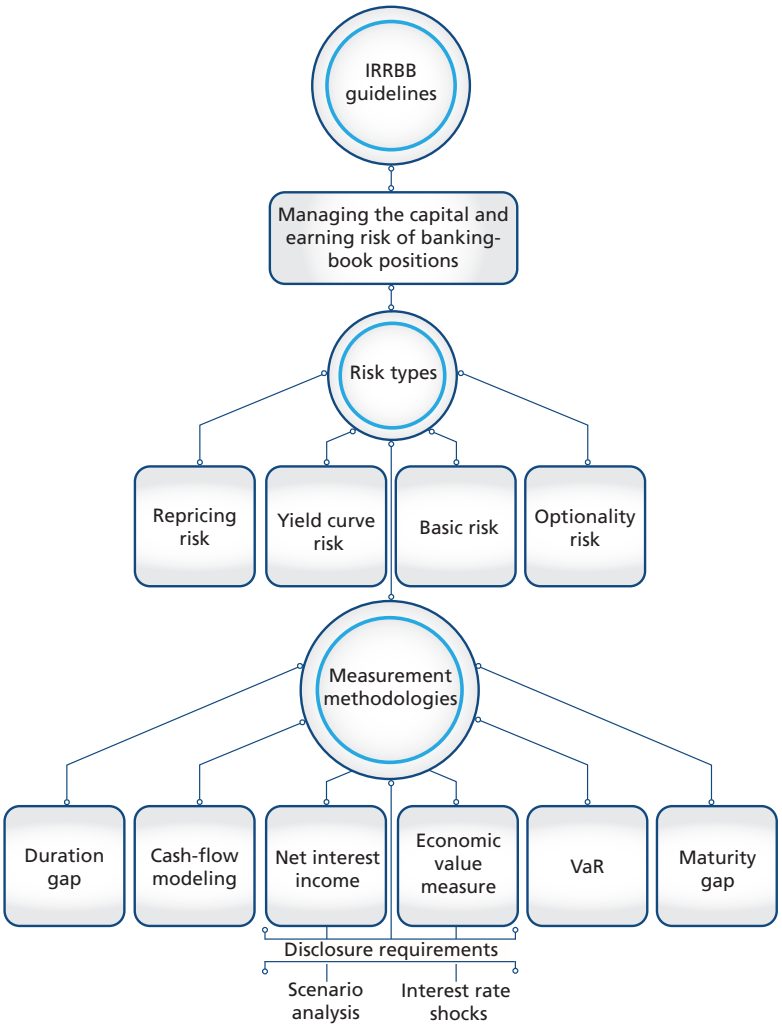
IRRBB also has significant impacts on banks' capital base, through amendments to the Capital Requirement Directive (CRD) and the Capital Requirements Regulation (CRR). In certain circumstances, the CDR requires local authorities to develop a standardized methodology for IRRBB calculation, while the CRR requires banks to report the likely impact of different interest rates on their capital and balance sheets.

Interest-rate risk analytics and modeling

A combination of IRRBB regulations and business drivers is transforming the interest-rate modeling framework globally. Interest-rate modeling frameworks vary by region, driven party by how regional product markets influence FIs' requirements and resources. On the trading book side in the US, for example, sophisticated interest-rate simulation techniques and prepayment risk models have been essential tools for hedging and pricing. IRRBB is now driving a robust and sophisticated analytics framework on the banking-book side, especially as regulators require metrics to be forecast under a range of conditions.

While complex interest-rate simulation is not new in banking, one current trend is for methodological convergence. Not only must banks simulate interest for their earnings projections, they must also develop a more market-oriented approach to assessing its effects on asset-backed securities (ABS). Net Economic Value (NEV) is a measurement that enables banks to assess their balance sheets based on present value. Calculations of NEV changes can be used to measure market impacts on assets and liabilities, and may also be used to assess the net value of a bank's worth under stressed interest-rate conditions.

Figure 12: EBA IRRBB compliance



Source: Chartis Research

In the past, stress-testing regimes have been driven largely by regulation, and were ad hoc in nature, or pre-determined by supervisory regimes. Currently there is a stronger drive among FIs for more business-oriented stress-testing frameworks that are more mathematically rigorous. Rather than relying on the generation of internal data, these stress tests imply their results and data from real market and business conditions.

For FIs, combining credit risk and interest-rate modeling is a particularly valuable way to develop market-oriented asset-value projections. This is a computationally intensive activity, however, and smaller institutions will struggle to run these simulations using on-premise tools and platforms.

[2] *The LCR and NSFR are minimum ratios designed to ensure that FIs have the appropriate funding to cover their cash-flow obligations through available high-quality assets and stable sources of funding (such as equity, insured customer deposits or long-term wholesale funding).*

Liquidity risk management

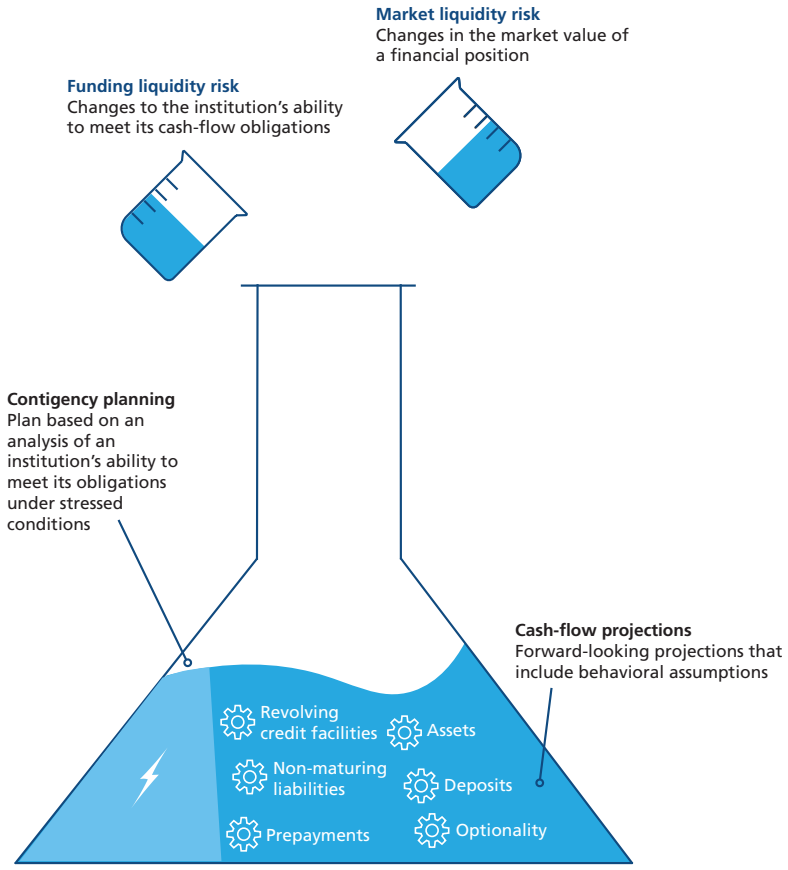
For effective ALM, banks must implement liquidity management frameworks alongside their interest-rate management (see Figure 13). Compared to interest-rate risk, businesses' and regulators' focus on liquidity risk is relatively new. The 2008 financial crisis highlighted a number of relevant factors, including banks' exposure to liquidity crises, their potential insolvency, and regulators' relative inattention to liquidity risk until that point.

The crisis forced regulators to focus on developing liquidity risk guidelines and regimes. The BCBS mandated both the LCR and the NSFR as part of its Basel III liquidity reforms.

To comply with the Basel III liquidity ratios, FIs will have to conduct frequent ratio calculations (sometimes even daily), based on effective data capture, efficient computation, and calculations in multiple currencies. Because of the stress-testing demands of NSFR and LCR, banks will have to incorporate another set of assumptions into their stress-testing frameworks. Managing regulatory liquidity risk requirements also creates significant reporting demands for banks, which will have to continuously disclose their ratio and liquidity metrics. How easy it is to comply with LCR is partly influenced by regional banking trends and local banks' resilience to liquidity issues. NSFR will likely affect banks with larger investment portfolios, because it sets different qualifications on what is considered a 'stable' funding source. Compliance and related balance sheet strategies are based on the nature of their deposit mix – retail deposits, for example, have a relatively low run-off rate[3] compared to wholesale deposits.

Another challenge that banks may face is reconciling their NSFR and LCR compliance. Amending the balance sheet for the LCR ratio may have a knock-on effect on the funding calculations for NSFR. While the calculations are intended to measure resilience over different timeframes, issues can arise when FIs align their balance sheet strategies for compliance. The COVID-19 pandemic has affected customers' behavior around how they deposit their money, and at the moment banks are experiencing increased volumes of deposits. However, while the pandemic's effects will inform banks' liquidity risk-management strategies, they should not rely on this pattern of customer behavior to create long-term funding plans.

Figure 13: Managing liquidity



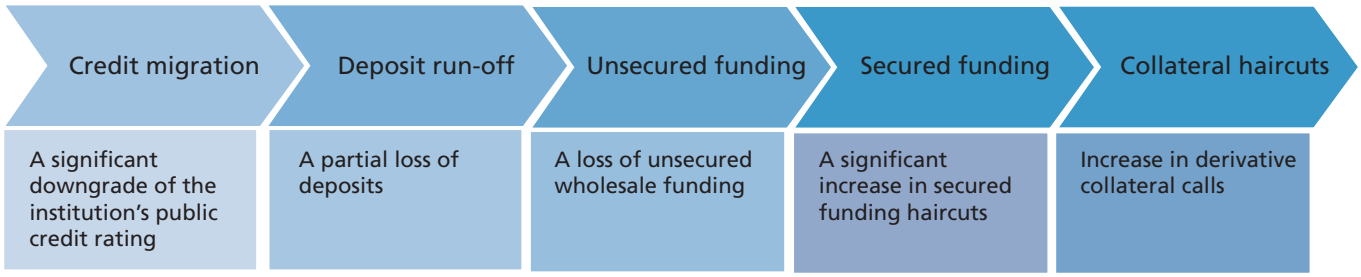
Source: Chartis Research

Liquidity risk analytics

Liquidity risk management relies on a bank's ability to meet its cash obligations when necessary, and this in turn is built on accurate cash-flow projections. However, a bank's exposure to liquidity risk can be highly complex, driven by several often 'non-rational' variables, and regulators now expect banks to incorporate customer behavior modeling into their balance sheet liquidity profile. Liquidity risk management is often an integration challenge, requiring portfolio and instrument data from different silos. Banks are also expected to stress-test their funding sources, to assess how their cash-flow projections are likely to change under different scenarios (see Figure 14). Institutions will also need to identify and declare a contingency funding plan, which will provide details of funding sources under stressed conditions.

[3] *A 'run-off rate' is the rate at which deposits are withdrawn.*

Figure 14: Liquidity stress contexts



Source: Chartis Research

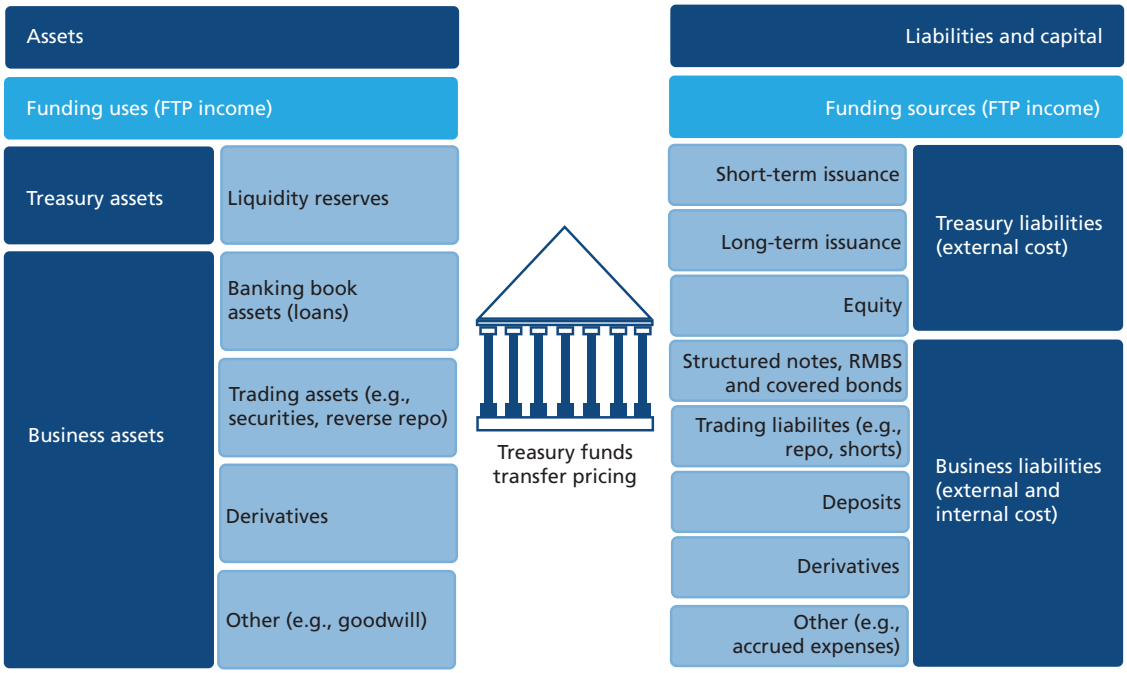
Funds transfer pricing

FTP is the mechanism FIs use to measure and distribute funds to different business units within the organization to enable them to take and lend deposits, and it is a primary responsibility of the treasury. The treasury determines a 'transfer price' for the funds it allocates to different business units, and this price dictates the pricing of products. Banks use FTP to manage their funding spread risk and to adapt their pricing and business models to their changing balance sheets and projected cash flows.

When performed effectively, FTP can give a bank an accurate view of its business unit's financial performance, in terms of both the use and sources of funding. It should also cultivate the treasury's influence over business units, in terms of governance and business strategy. FTP can be considered a central core analytical framework, and a risk management center that ties the banking business together into a coherent whole (see Figure 15).

Historically, the treasury enjoyed relative freedom in the way it organized and performed funding practices. But banks' treasury departments continue to become more complex in terms of their responsibilities and reporting lines, while regulation and market conditions are pushing FIs to focus more on effective FTP[4].

Figure 15: FTP as the central core analytical framework



Source: Chartis Research

[4] *Traditionally, the treasury department's role has been to manage several varied responsibilities. While for this report we will largely discuss the treasury department in the context of FTP, hedging and investment, we recognize the variation in architecture and responsibilities that exists between different treasury departments. We also note that some institutions – especially large banks – often have multiple ancillary treasury departments. Large banks with major business lines may also have internal business treasuries that will govern micro-funding decisions.*

Figure 16: The different elements of effective FTP

Source: Chartis Research

Achieving an effective FTP framework

Determining the fund transfer price of a product requires various inputs from across the bank. Transfer prices are based on maturity rates, interest-rate profiles, credit risk factors, currency information, and liquidity rules/premiums and capital costs. FTP frameworks that provide granular detail at the product and transaction level, with flexible calculation methodologies that incorporate the multiplicity of risk types and factors entailed by FTP, will prove the most effective (see Figure 16).

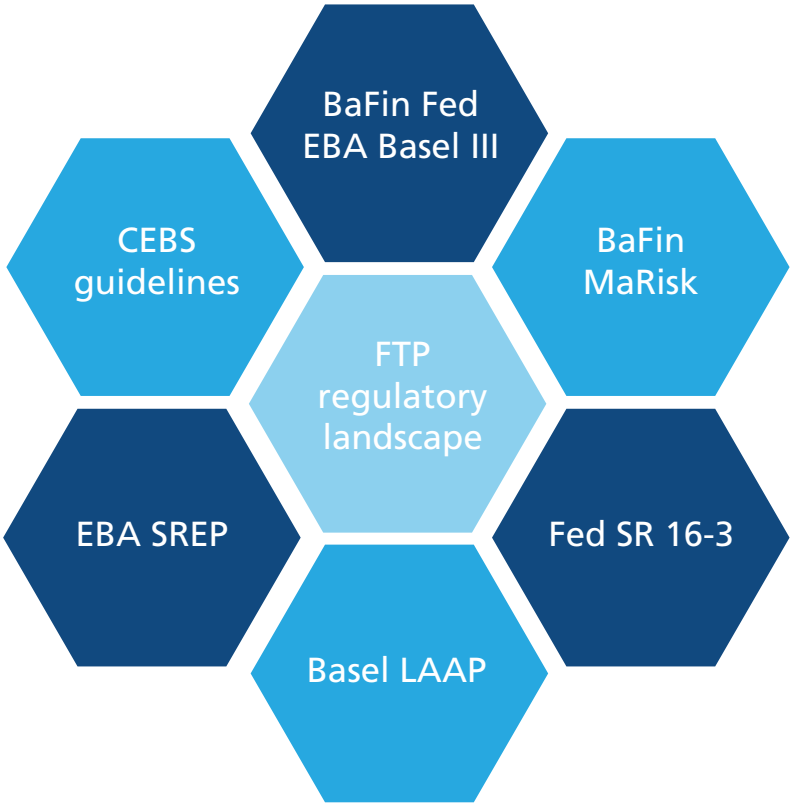
The 2007/8 financial crisis highlighted the pervasive inadequacy of risk-adjusted pricing within FIs, particularly in relation to product liquidity charges. Put simply, in the past funding costs rose, and risk was not incorporated into the price of products. Regulators and institutions alike are now focused on capturing liquidity risk, and one vital mechanism for achieving this is via an effective FTP framework.

The regulation surrounding FTP (see Figure 17) is increasingly prescriptive in the language it uses. Nevertheless, while it is a core feature of supervisory bodies' reviews, compared with other segments of ALM discussed in this report, the regulatory rules and guidelines affecting FTP are still not as prescriptive at the lower level, giving banks a degree of freedom. The importance banks place on their FTP policy depends partly on the type of bank concerned and its regional operations. Notably, if a bank's business model does not rely on wholesale unsecured funding, its FTP framework may not be much of a concern. However, there is a broader trend in banking to diversify funding sources, including sourcing higher levels of stable retail funding. The UK banking sector in particular has reduced its overall reliance on wholesale funding, with a 15% drop on bank's balance sheets in the past decade[5].

The upcoming transition from the interbank offered rate (IBOR) in 2021 will have significant effects on banks' funding frameworks. Interbank rates are set to be replaced with risk-free rates (RFRs), which will be based on real transaction data. Adapting to RFRs will require a flexible approach from treasuries as they come to terms with new basic-rate calculation methodologies.

To stay competitive in the market, banks must have an effective FTP framework, regardless of their regulatory and market context. The growing sophistication of industry practices is setting an advanced standard that incorporates FTP methodology, management information and

Figure 17: The regulation surrounding FTP



Source: Chartis Research

[5] **https://www.bankofengland.co.uk/bank-overground/2019/has-the-link-between-wholesale-bank-funding-costs-and-lending-rates-changed**

governance. FTP can be a centralizing force, unifying disparate risk measures and their associated analytics via flexible and up-to-date methodologies.

FTP should be embedded into a wider funding policy framework and governance structure, and FTP frameworks should be developed/reassessed in the light of shifting regulatory landscapes; FTP is also a way to provide information to management. Ultimately FTP policies should cut a bilateral path through banks, traveling from senior management and individual business lines, and a comprehensive FTP framework will enable accurate product pricing that quantifies risk and eases the navigation of regulatory costs.

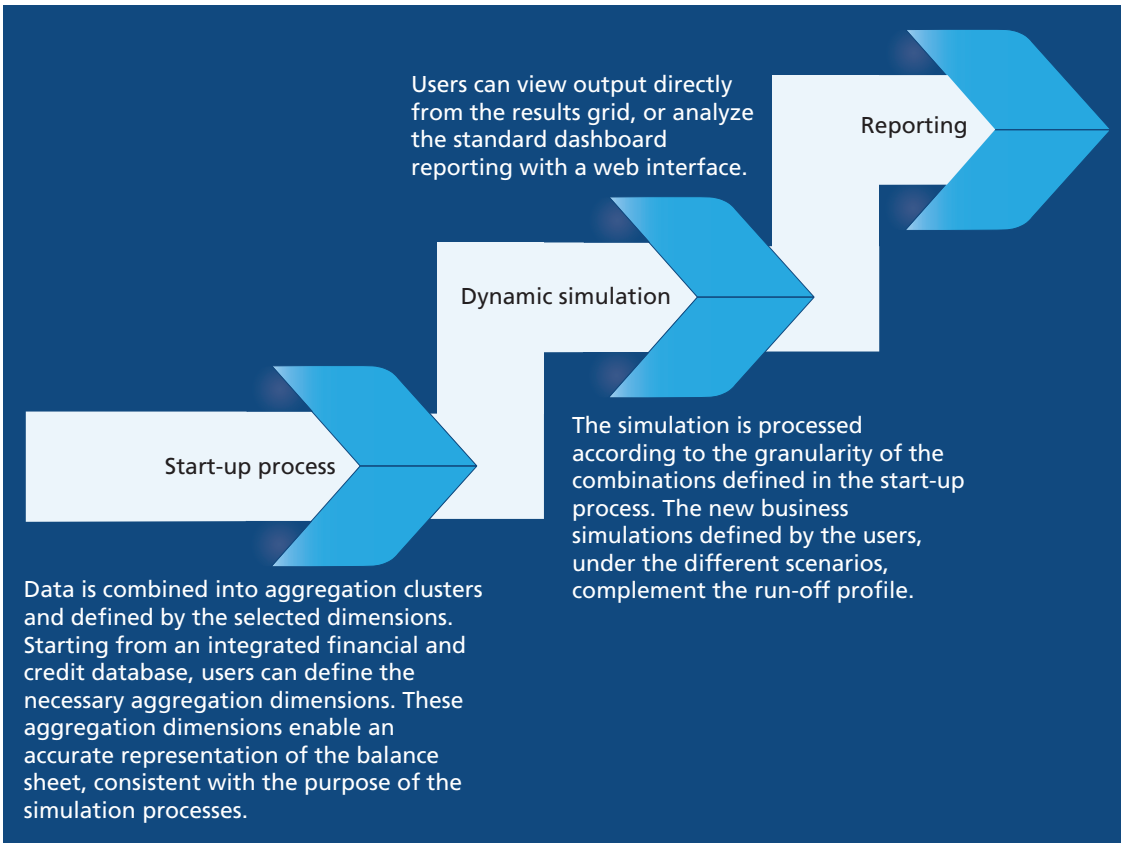
Bringing it together: an ALM technology environment to aspire to

As the quantitative revolution progresses, end users and vendors should aim for clear goals in their technology development, based around a few core themes that signify an increased level of ALM sophistication. These include the integration of multiple risk types, granular analysis and data aggregation, and a methodologically clear and standardized overarching framework.

Chartis has outlined an ALM technology environment that FIs should strive for in the banking book (see Figure 18), and which should involve the following.

- A simulation solution (such as an economic scenario generator [ESG]) that integrates ALM, liquidity, credit strategies and performance analyses by consistently projecting all indicators: LCR, NSFR, FTP, risk-weighted assets (RWAs) and capital.
- A system that constitutes an essential tool for supporting budgeting, fund and capital planning, to find the optimal balance between risk and profitability, while anticipating the corresponding impact on regulatory compliance.
- Ideally, customized trees in the simulation and analytical process, which enable multiple 'waterfall' logics to insert strategies on new volumes and spreads, with a 'cascading' mechanism at the lower hierarchical levels.

Figure 18: An ALM environment to aspire to



Source: Chartis Research

3. Vendor landscape

The ALM technology space has a long legacy across the financial services industry. The insurance and trading book sectors have been pushing for sophisticated tools and methodological standardization in key areas of strength for quite some time. It is now the turn of the banking book to experience a huge shift in demand for technology, which is prompting new developments in analytics.

ALM – an analytics focus

Vendors are responding to the growing demand for ALM analytics, increasing their analytical infrastructure either by building it internally or partnering with a relevant specialist. Firms are also making substantial investments in analytics, and building up their stress testing, behavioral modeling and interest-rate simulation functionality. Many have also been working toward a full interest-rate simulation framework. Nevertheless, the level of investment and success vendors have had in competing in the context of the new ALM standard varies considerably.

From the perspective of extended analytics, there is strong demand for economic scenario generation and reverse stress-testing frameworks, although development in both of these areas is still in its early stages. Vendors are still working to standardize these practices and integrate them into the wider ALM analytical environment. Scenario generation and stress testing are yet to be consolidated into the fully fledged economic scenario generation systems that insurers implement. Some vendors are opening up their analytics to cater more effectively to different banks' idiosyncratic needs, and allowing banks' ALM quants to extend and modify them.

FTP and profitability analysis

At a basic level, FTP is part of the ALM process – fund pricing curves are the basis against which all products are priced – and all ALM providers have the capacity to offer FTP. However, the real issue is the effectiveness and theoretical soundness of the profitability analysis that is built against the system. Many vendors rely on the core ALM system and its ability to simulate cash flows for profitability analysis. Although profitability analysis operates alongside cash-flow generation, supporting detailed profitability analysis can be a considerable challenge. Core ALM systems cannot necessarily create granular cash flows at the level required for the most effective profitability analysis. An interest simulation engine that enables business forecasting may be theoretically similar to a tool that assesses granular product profitability by business line and geography. However, there are considerable practical differences. To achieve granular and specific business and profitability analysis, vendors must be able to 'slice and dice' cash flows and discount them with the appropriate FTP curves.

The more competitive technology vendors in the FTP space tend to have a more specialized focus on profitability analysis and vast granular cash-flow generation. However, the strength of a solution is not always consistent across regions. European banks tend to have a much more holistic view of their products, whereas US banks have a very 'product-centric' view. This can affect an institution's expectation of cash-flow aggregation and its profitability perspectives.

Capital and balance sheet optimization

Capital and balance sheet optimization remain among the more ad hoc elements of ALM, with considerable variance in practice between different FIs. Some banks still take the traditional approach of semi-frequent optimization at a macro level, while others take a more dynamic approach. This approach includes assessments of the value and success of managerial decision making through the lens of the optimization framework.

The vendor space for capital and balance sheet optimization shows considerable variation, and the strongest players are those that can offer the more dynamic approach. More competitive vendors offer multiple optimizations that give FIs a view of the effects that different managerial decisions can have on portfolios. The more successful vendors in this space are able to cater to more specific and granular decision making.

Liquidity risk management

LRM is a process that relies heavily on data integration. A lot of the data that is critical to the process must be handled at a very granular level, and often resides in systems that are outside the control of the treasury or ALCO group. Gathering all the necessary data for LCR and NSFR can

be a big and challenging task, especially for larger institutions. In fact, in larger institutions, addressing LCR and NSFR can end up being as much of an analytical exercise as an integration project.

Chartis RiskTech Quadrant® and vendor capabilities for ALM technology solutions, 2021

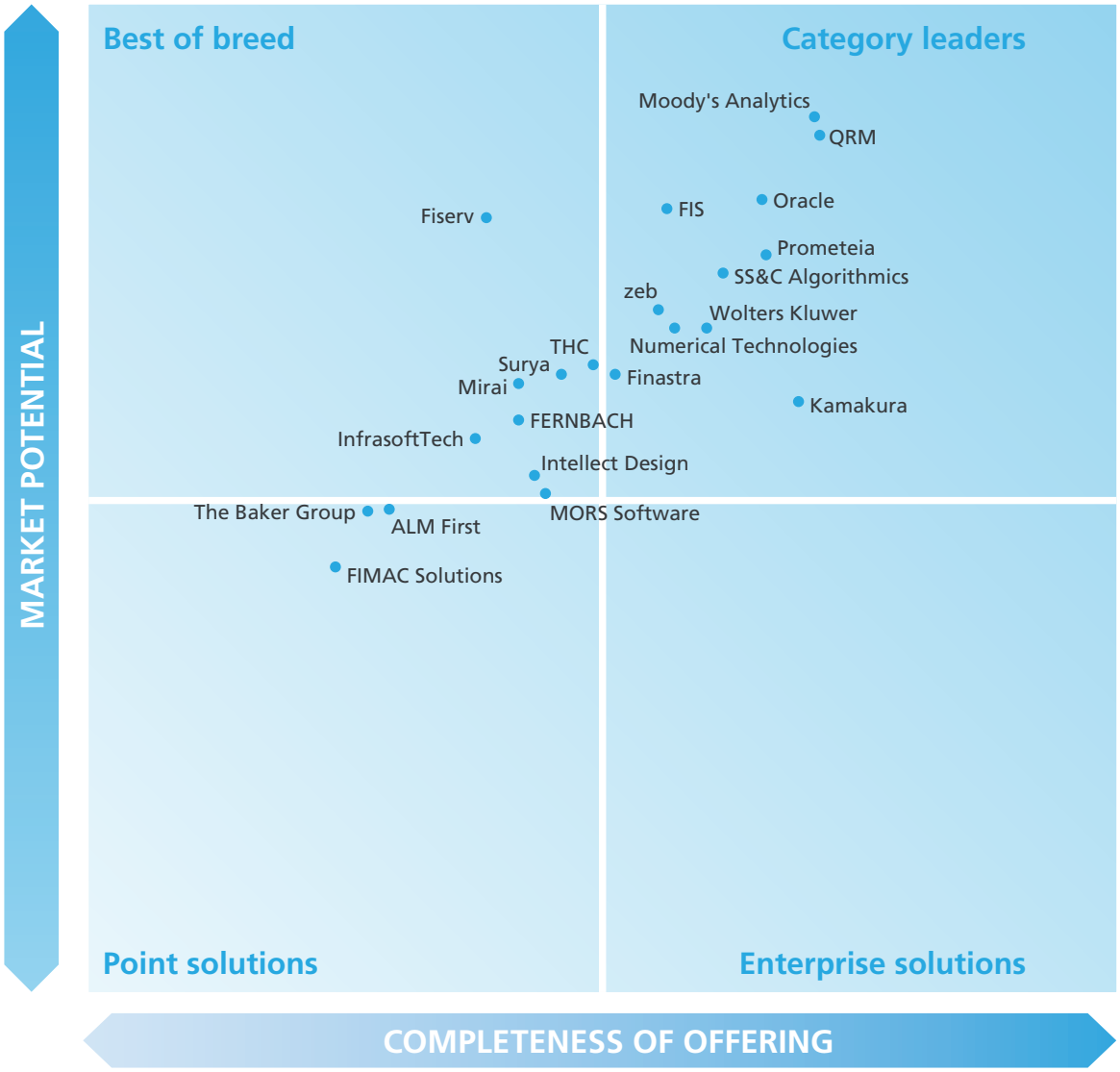
Figure 19 illustrates Chartis' view of the vendor landscape for ALM solutions. Table 1 lists the completeness of offering and market potential criteria we used to assess the vendors. Table 2 lists the vendor capabilities in this area.

Table 1: Assessment criteria for vendors of ALM solutions, 2021

Completeness of offering	Market potential
• Capabilities and breadth of optimization • Scenario management systems (including support for specific ESGs) • Stress testing/reverse stress testing • Interest rate modeling • Simulation engine(s) capability • Liquidity risk • Balance sheet optimization • Behavioral modeling • Data management • Integration capabilities	• Customer satisfaction • Market penetration • Growth strategy • Financials • Business model

Source: Chartis Research

Figure 19: RiskTech Quadrant® for ALM solutions, 2021



Source: Chartis Research

Table 2: Vendor capabilities for ALM solutions, 2021

Vendor	Capabilities and breadth of optimization	Scenario management systems	Stress testing/ reverse stress testing	Interest rate modeling	Simulation engine(s) capability
ALM First	**	**	**	**	**
The Baker Group	**	**	**	**	**
FERNBACH	**	**	**	**	**
FIMAC Solutions	**	**	**	**	**
Finastra	**	**	***	**	**
FIS	**	**	**	***	****
Fiserv	**	**	**	**	**
InfrasoftTech	**	**	**	**	**
Intellect Design	**	**	**	**	**
Kamakura	****	****	****	****	****
Mirai	**	**	**	**	**
Moody's Analytics	****	****	****	****	****
MORS Software	**	***	**	**	**
Numerical Technologies	***	***	***	***	**
Oracle	***	***	***	**	**
Prometeia	****	****	***	***	***
QRM	****	****	****	****	****
SS&C Algorithmics	***	***	***	****	****
Surya	**	**	**	**	**
THC	***	***	***	****	****
Wolters Kluwer	***	***	**	**	***
zeb	***	***	**	**	***

*Key: **** = Best-in-class capabilities; *** = Advanced capabilities; ** = Meets industry requirements; * = Partial coverage/component capability*
Source: Chartis Research

Table 2: Vendor capabilities for ALM solutions, 2021 (continued)

Vendor	Liquidity risk	Balance sheet optimization	Behavioral modeling	Data management	Integration capabilities
ALM First	**	**	**	**	**
The Baker Group	**	**	**	**	**
FERNBACH	**	**	**	**	**
FIMAC Solutions	**	*	**	**	**
Finastra	**	***	**	**	***
FIS	****	**	**	***	***
Fiserv	**	**	**	**	**
InfrasoftTech	**	**	**	**	**
Intellect Design	***	**	**	**	****
Kamakura	***	***	****	**	**
Mirai	**	**	**	***	**
Moody's Analytics	****	***	***	***	***
MORS Software	***	**	**	***	**
Numerical Technologies	**	**	**	***	***
Oracle	***	***	***	****	****
Prometeia	***	****	**	***	***
QRM	***	****	***	***	**
SS&C Algorithmics	***	**	**	***	**
Surya	**	**	**	**	**
THC	**	**	**	**	*
Wolters Kluwer	***	***	**	****	***
zeb	**	***	**	**	**

*Key: **** = Best-in-class capabilities; *** = Advanced capabilities; ** = Meets industry requirements; * = Partial coverage/component capability*
Source: Chartis Research

Chartis RiskTech Quadrant® and vendor capabilities for FTP technology solutions, 2021

Figure 20 illustrates Chartis' view of the vendor landscape for ALM solutions. Table 3 lists the completeness of offering and market potential criteria we used to assess the vendors. Table 4 lists the vendor capabilities in this area.

Table 3: Assessment criteria for vendors of FTP solutions, 2021

Completeness of offering	Market potential
• Business line management	• Customer satisfaction
• Hedge management	• Market penetration
• Simulation	• Growth strategy
• Data management	• Financials
• Pricing	• Business model

Source: Chartis Research

Figure 20: RiskTech Quadrant® for FTP solutions, 2021

Source: Chartis Research

Table 4: Vendor capabilities for FTP solutions, 2021

Vendor	Business line management	Hedge management	Simulation	Data management	Pricing
ALM First	**	**	**	**	**
The Baker Group	**	**	**	**	**
FERNBACH	**	**	**	**	**
FIMAC Solutions	**	**	**	**	**
Finastra	**	**	**	**	**
FIS	***	***	**	**	**
Fiserv	**	**	**	***	**
InfrasoftTech	**	**	**	**	**
Intellect Design	**	**	**	***	**
Kamakura	***	****	****	**	***
Mirai	**	**	**	***	**
Moody's Analytics	***	****	****	***	***
MORS Software	**	**	**	***	**
Numerical Technologies	**	***	***	**	**
Oracle	***	***	****	****	****
Prometeia	***	***	***	***	**
QRM	**	***	****	**	****
SS&C Algorithmics	***	***	***	***	**
Surya	***	***	**	**	**
THC	**	****	****	**	***
Wolters Kluwer	**	**	**	****	**
zeb	**	**	***	**	**

*Key: **** = Best-in-class capabilities; *** = Advanced capabilities; ** = Meets industry requirements; * = Partial coverage/component capability*
Source: Chartis Research

Chartis RiskTech Quadrant® and vendor capabilities for LRM technology solutions, 2021

Figure 21 illustrates Chartis' view of the vendor landscape for ALM solutions. Table 5 lists the completeness of offering and market potential criteria we used to assess the vendors. Table 6 lists the vendor capabilities in this area.

Table 5: Assessment criteria for vendors of LRM solutions, 2021

Completeness of offering	Market potential
• Scenario generation	• Customer satisfaction
• Cash flow projections	• Market penetration
• Integration capabilities	• Growth strategy
• Reporting	• Financials
• LCR & NSFR	• Business model

Source: Chartis Research

Figure 21: RiskTech Quadrant® for LRM solutions, 2021

Source: Chartis Research

Table 6: Vendor capabilities for LRM solutions, 2021

Vendor	Scenario generation	Cash flow projections	Integration capabilities	Reporting	LCR & NSFR
AxiomSL	*	**	****	****	**
FERNBACH	**	**	**	**	***
Finastra	***	***	***	**	****
FIS	****	***	***	***	**
Fiserv	**	**	**	**	*
InfrasoftTech	**	**	**	**	****
Intellect Design	**	**	**	**	***
Kamakura	****	****	**	**	**
Mirai	**	**	**	***	***
Moody's Analytics	****	***	**	***	***
MORS Software	**	**	**	**	**
Numerical Technologies	**	***	**	***	***
Oracle	***	****	****	***	****
Prometeia	****	***	***	****	***
QRM	****	****	**	**	**
SS&C Algorithmics	****	****	**	***	***
Surya	***	**	**	**	**
THC	***	**	**	***	*
Wolters Kluwer	***	***	****	***	****
zeb	***	****	**	***	***

*Key: **** = Best-in-class capabilities; *** = Advanced capabilities; ** = Meets industry requirements; * = Partial coverage/component capability*
Source: Chartis Research

Chartis RiskTech Quadrant® and vendor capabilities for capital and balance sheet optimization technology solutions, 2021

Figure 22 illustrates Chartis' view of the vendor landscape for capital and balance sheet optimization solutions. Table 7 lists the completeness of offering and market potential criteria we used to assess the vendors. Table 8 lists the vendor capabilities in this area.

Table 7: Assessment criteria for vendors of capital and balance sheet optimization solutions, 2021

Completeness of offering	Market potential
• Breadth of asset class/ business line coverage • Optimization engine • Scenario and simulation frameworks • Data management • Business planning and analysis	• Customer satisfaction • Market penetration • Growth strategy • Financials • Business model

Source: Chartis Research

Figure 22: RiskTech Quadrant® for capital and balance sheet optimization solutions, 2021

Source: Chartis Research

Table 8: Vendor capabilities for capital and balance sheet optimization solutions, 2021

Vendor	Breadth of asset class/ business line coverage	Optimization engine	Scenario and simulation frameworks	Data management	Business planning and analysis
FERNBACH	**	**	**	**	**
Finastra	***	****	***	***	**
FIS	**	**	**	***	**
Fiserv	**	**	**	**	**
InfrasoftTech	***	**	**	***	**
Intellect Design	***	**	**	**	**
Kamakura	****	****	****	**	***
Mirai	**	**	**	***	**
Moody's Analytics	***	***	****	****	****
MORS Software	*	****	**	**	**
Numerical Technologies	***	***	***	**	**
Oracle	**	***	****	****	****
Prometeia	****	****	****	***	****
QRM	****	****	****	**	***
SS&C Algorithmics	***	****	****	****	***
Surya	**	**	**	**	**
THC	**	**	****	**	***
Wolters Kluwer	**	**	**	****	**
zeb	***	**	***	***	**

*Key: **** = Best-in-class capabilities; *** = Advanced capabilities; ** = Meets industry requirements; * = Partial coverage/component capability*
Source: Chartis Research

4. Appendix A: RiskTech Quadrant® methodology

Chartis is a research and advisory firm that provides technology and business advice to the global risk management industry. Chartis provides independent market intelligence regarding market dynamics, regulatory trends, technology trends, best practices, competitive landscapes, market sizes, expenditure priorities, and mergers and acquisitions. Chartis' RiskTech Quadrant® reports are written by experienced analysts with hands-on experience of selecting, developing, and implementing risk management systems for a variety of international companies in a range of industries including banking, insurance, capital markets, energy, and the public sector.

Chartis' research clients include leading financial services firms and Fortune 500 companies, leading consulting firms, and risk technology vendors. The risk technology vendors that are evaluated in the RiskTech Quadrant® reports can be Chartis clients or firms with whom Chartis has no relationship. Chartis evaluates all risk technology vendors using consistent and objective criteria, regardless of whether or not they are a Chartis client.

Where possible, risk technology vendors are given the opportunity to correct factual errors prior to publication, but cannot influence Chartis' opinion. Risk technology vendors cannot purchase or influence positive exposure. Chartis adheres to the highest standards of governance, independence, and ethics.

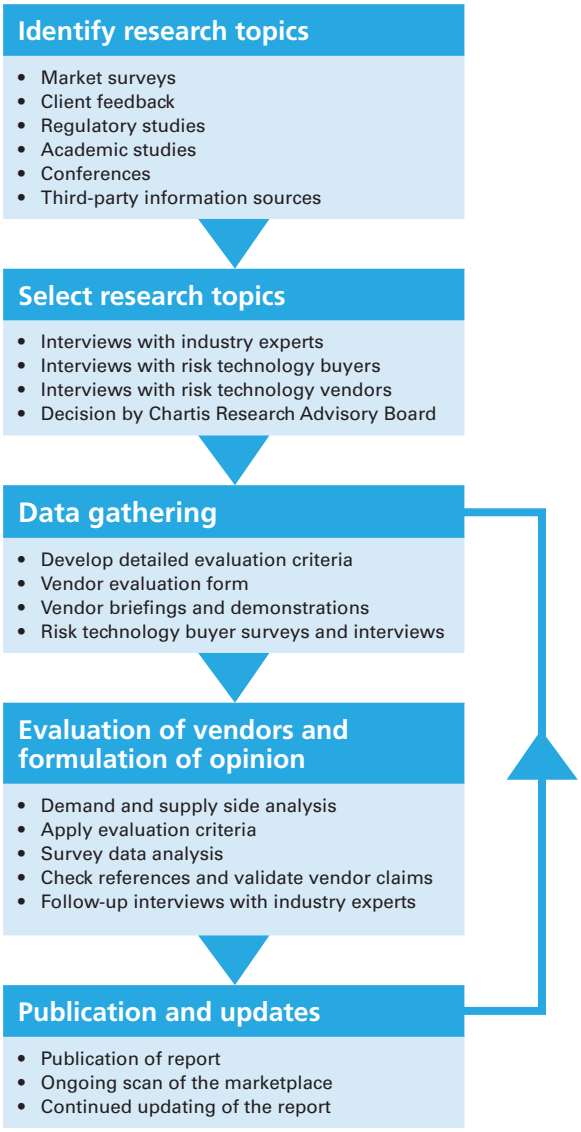
Inclusion in the RiskTech Quadrant®

Chartis seeks to include risk technology vendors that have a significant presence in a given target market. The significance may be due to market penetration (e.g. large client-base) or innovative solutions. Chartis does not give preference to its own clients and does not request compensation for inclusion in a RiskTech Quadrant® report. Chartis utilizes detailed and domain-specific 'vendor evaluation forms' and briefing sessions to collect information about each vendor. If a vendor chooses not to respond to a Chartis vendor evaluation form, Chartis may still include the vendor in the report. Should this happen, Chartis will base its opinion on direct data collated from risk technology buyers and users, and from publicly available sources.

Research process

The findings and analyses in the RiskTech Quadrant® reports reflect our analysts' considered opinions, along with research into market trends, participants, expenditure patterns, and best practices. The research lifecycle usually takes several months, and the analysis is validated through several phases of independent verification. Figure 23 below describes the research process.

Figure 23: RiskTech Quadrant® research process



Source: Chartis Research

Chartis typically uses a combination of sources to gather market intelligence. These include (but are not limited to):

- **Chartis vendor evaluation forms.** A detailed set of questions covering functional and non-functional aspects of vendor solutions, as well as organizational and market factors. Chartis' vendor evaluation forms are based on practitioner level expertise and input from real-life risk technology projects, implementations, and requirements analysis.
- **Risk technology user surveys.** As part of its ongoing research cycle, Chartis systematically surveys risk technology users and buyers, eliciting feedback on various risk technology vendors, satisfaction levels, and preferences.
- **Interviews with subject matter experts.** Once a research domain has been selected, Chartis undertakes comprehensive interviews and briefing sessions with leading industry experts, academics, and consultants on the specific domain to provide deep insight into market trends, vendor solutions, and evaluation criteria.
- **Customer reference checks.** These are telephone and/or email checks with named customers of selected vendors to validate strengths and weaknesses, and to assess post-sales satisfaction levels.
- **Vendor briefing sessions.** These are face-to-face and/or web-based briefings and product demonstrations by risk technology vendors. During these sessions, Chartis experts ask in-depth, challenging questions to establish the real strengths and weaknesses of each vendor.
- **Other third-party sources.** In addition to the above, Chartis uses other third-party sources of information such as conferences, academic and regulatory studies, and collaboration with leading consulting firms and industry associations.

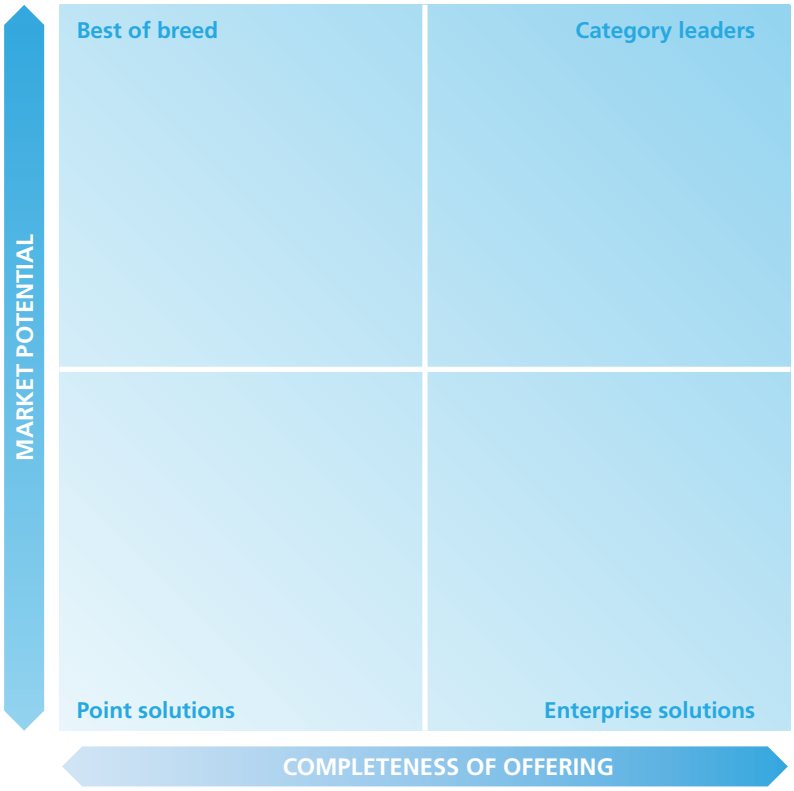
Evaluation criteria

The RiskTech Quadrant® (see Figure 24) evaluates vendors on two key dimensions:

1. Completeness of offering

2. Market potential

Figure 24: RiskTech Quadrant®



Source: Chartis Research

We develop specific evaluation criteria for each piece of quadrant research from a broad range of overarching criteria, outlined below. By using domain-specific criteria relevant to each individual risk, we can ensure transparency in our methodology, and allow readers to fully appreciate the rationale for our analysis.

Completeness of offering

- **Depth of functionality.** The level of sophistication and amount of detailed features in the software product (e.g. advanced risk models, detailed and flexible workflow, domain-specific content). Aspects assessed include: innovative functionality, practical relevance of features, user-friendliness, flexibility, and embedded intellectual property. High scores are given to those firms that achieve an appropriate balance between sophistication and user-friendliness. In addition, functionality linking risk to performance is given a positive score.
- **Breadth of functionality.** The spectrum of requirements covered as part of an enterprise risk management system. This will vary for

each subject area, but special attention will be given to functionality covering regulatory requirements, multiple risk classes, multiple asset classes, multiple business lines, and multiple user types (e.g. risk analyst, business manager, CRO, CFO, Compliance Officer). Functionality within risk management systems and integration between front-office (customer-facing) and middle/back office (compliance, supervisory, and governance) risk management systems are also considered.

- **Data management and technology infrastructure.** The ability of risk management systems to interact with other systems and handle large volumes of data is considered to be very important. Data quality is often cited as a critical success factor and ease of data access, data integration, data storage, and data movement capabilities are all important factors. Particular attention is given to the use of modern data management technologies, architectures, and delivery methods relevant to risk management (e.g. in-memory databases, complex event processing, component-based architectures, cloud technology, software-as-a-service). Performance, scalability, security, and data governance are also important factors.

- **Risk analytics.** The computational power of the core system, the ability to analyze large amounts of complex data in a timely manner (where relevant in real time), and the ability to improve analytical performance are all important factors. Particular attention is given to the difference between 'risk' analytics and standard 'business' analytics. Risk analysis requires such capabilities as non-linear calculations, predictive modeling, simulations, scenario analysis, etc.

- **Reporting and presentation layer.** The ability to present information in a timely manner, the quality and flexibility of reporting tools, and ease of use are important for all risk management systems. Particular attention is given to the ability to do ad-hoc 'on-the-fly' queries (e.g. what-if-analysis), as well as the range of 'out-of-the-box' risk reports and dashboards.

Market potential

- **Business model**. Includes implementation and support and innovation (product, business model and organizational). Important factors include size and quality of implementation team, approach to software implementation, and post-sales support and training. Particular attention is given to 'rapid' implementation methodologies and 'packaged' services offerings. Also evaluated are new ideas, functionality and technologies to solve specific risk management problems. Speed to market, positioning, and translation into incremental revenues are also important success factors in launching new products.

- **Market penetration**. Volume (i.e. number of customers) and value (i.e. average deal size) are considered important. Rates of growth relative to sector growth rates are also evaluated. Also covers brand awareness, reputation, and the ability to leverage current market position to expand horizontally (with new offerings) or vertically (into new sectors).

- **Financials**. Revenue growth, profitability, sustainability, and financial backing (e.g. the ratio of license to consulting revenues) are considered key to scalability of the business model for risk technology vendors.

- **Customer satisfaction**. Feedback from customers is evaluated, regarding after-sales support and service (e.g. training and ease of implementation), value for money (e.g. price to functionality ratio) and product updates (e.g. speed and process for keeping up to date with regulatory changes).

- **Growth strategy**. Recent performance is evaluated, including financial performance, new product releases, quantity and quality of contract wins, and market expansion moves. Also considered are the size and quality of the sales force, sales distribution channels, global presence, focus on risk management, messaging, and positioning. Finally, business insight and understanding, new thinking, formulation and execution of best practices, and intellectual rigor are considered important.

Quadrant descriptions

Point solutions

- Point solutions providers focus on a small number of component technology capabilities, meeting a critical need in the risk technology market by solving specific risk management problems with domain-specific software applications and technologies.
- They are often strong engines for innovation, as their deep focus on a relatively narrow area generates thought leadership and intellectual capital.
- By growing their enterprise functionality and utilizing integrated data management, analytics and BI capabilities, vendors in the point solutions category can expand their completeness of offering, market potential and market share.

Best-of-breed

- Best-of-breed providers have best-in-class point solutions and the ability to capture significant market share in their chosen markets.
- They are often distinguished by a growing client base, superior sales and marketing execution, and a clear strategy for sustainable, profitable growth. High performers also have a demonstrable track record of R&D investment, together with specific product or 'go-to-market' capabilities needed to deliver a competitive advantage.
- Focused functionality will often see best-of-breed providers packaged together as part of a comprehensive enterprise risk technology architecture, co-existing with other solutions.

Enterprise solutions

- Enterprise solutions providers typically offer risk management technology platforms, combining functionally-rich risk applications with comprehensive data management, analytics and BI.
- A key differentiator in this category is the openness and flexibility of the technology architecture and a 'toolkit' approach to risk analytics and reporting, which attracts larger clients.
- Enterprise solutions are typically supported with comprehensive infrastructure and service capabilities, and best-in-class technology delivery. They also combine risk management content, data and software to provide an integrated 'one-stop-shop' for buyers.

Category leaders

- Category leaders combine depth and breadth of functionality, technology and content with the required organizational characteristics to capture significant share in their market.
- Category leaders demonstrate a clear strategy for sustainable, profitable growth, matched with best-in-class solutions and the range and diversity of offerings, sector coverage and financial strength to absorb demand volatility in specific industry sectors or geographic regions.
- Category leaders will typically benefit from strong brand awareness, global reach and strong alliance strategies with leading consulting firms and systems integrators.

5. How to use research and services from Chartis

In addition to our flagship industry reports, Chartis offers customized information and consulting services. Our in-depth knowledge of the risk technology market and best practice allows us to provide high-quality and cost-effective advice to our clients. If you found this report informative and useful, you may be interested in the following services from Chartis.

For risk technology buyers

If you are purchasing risk management software, Chartis's vendor selection service is designed to help you find the most appropriate risk technology solution for your needs.

We monitor the market to identify the strengths and weaknesses of the different risk technology solutions, and track the post-sales performance of companies selling and implementing these systems. Our market intelligence includes key decision criteria such as TCO (total cost of ownership) comparisons and customer satisfaction ratings.

Our research and advisory services cover a range of risk and compliance management topics such as credit risk, market risk, operational risk, GRC, financial crime, liquidity risk, asset and liability management, collateral management, regulatory compliance, risk data aggregation, risk analytics and risk BI.

Our vendor selection services include:

- Buy vs. build decision support.
- Business and functional requirements gathering.
- Identification of suitable risk and compliance implementation partners.
- Review of vendor proposals.
- Assessment of vendor presentations and demonstrations.
- Definition and execution of Proof-of-Concept (PoC) projects.
- Due diligence activities.

For risk technology vendors

Strategy

Chartis can provide specific strategy advice for risk technology vendors and innovators, with a special focus on growth strategy, product direction, go-to-market plans, and more. Some of our specific offerings include:

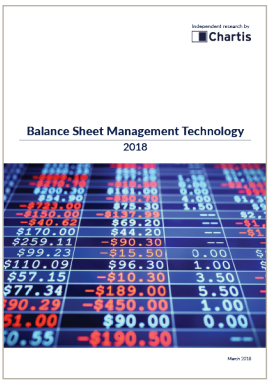
- Market analysis, including market segmentation, market demands, buyer needs, and competitive forces.
- Strategy sessions focused on aligning product and company direction based upon analyst data, research, and market intelligence.
- Advice on go-to-market positioning, messaging, and lead generation.
- Advice on pricing strategy, alliance strategy, and licensing/pricing models.

Thought leadership

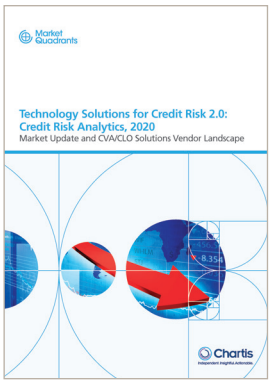
Risk technology vendors can also engage Chartis to provide thought leadership on industry trends in the form of in-person speeches and webinars, as well as custom research and thought-leadership reports. Target audiences and objectives range from internal teams to customer and user conferences. Some recent examples include:

- Participation on a 'Panel of Experts' at a global user conference for a leading Global ERM (Enterprise Risk Management) software vendor.
- Custom research and thought-leadership paper on Basel 3 and implications for risk technology.
- Webinar on Financial Crime Risk Management.
- Internal education of sales team on key regulatory and business trends and engaging C-level decision makers.

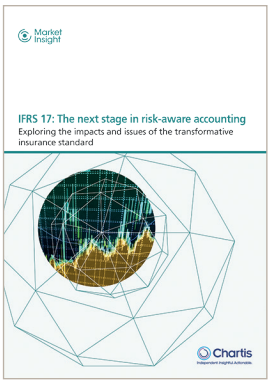
6. Further reading



Balance Sheet Management Technology, 2018

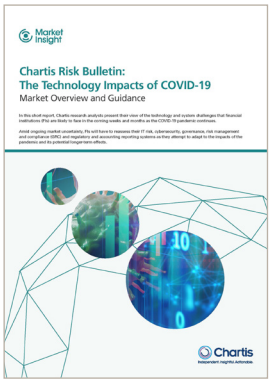


Technology Solutions for Credit Risk 2.0: Credit Risk Analytics, 2020

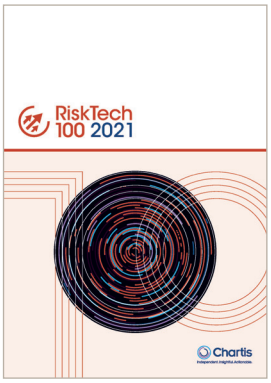


IFRS 17: The Next Stage in Risk-Aware Accounting

IFRS 9 Technology Solutions: Market Update 2017



Chartis Risk Bulletin: The Technology Impacts of COVID-19



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For all these reports, see **www.chartis-research.com**