

Vendor Analysis: SAS

ALM Technology Systems, 2023



About Chartis

Chartis Research is the leading provider of research and analysis on the global market for risk technology. It is part of Infopro Digital, which owns market-leading brands such as Risk and WatersTechnology. Chartis' goal is to support enterprises as they drive business performance through improved risk management, corporate governance and compliance, and to help clients make informed technology and business decisions by providing in-depth analysis and actionable advice on virtually all aspects of risk technology. Areas of expertise include:

- Credit risk.
- Operational risk and governance, risk management and compliance (GRC).
- Market risk.
- Asset and liability management (ALM) and liquidity risk.
- Energy and commodity trading risk.
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- Cyber risk management.
- Insurance risk.
- Regulatory requirements.
- Wealth advisory.
- Asset management.

Chartis focuses on risk and compliance technology, giving 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 developing and implementing risk management systems and programs for Fortune 500 companies and leading consulting firms.

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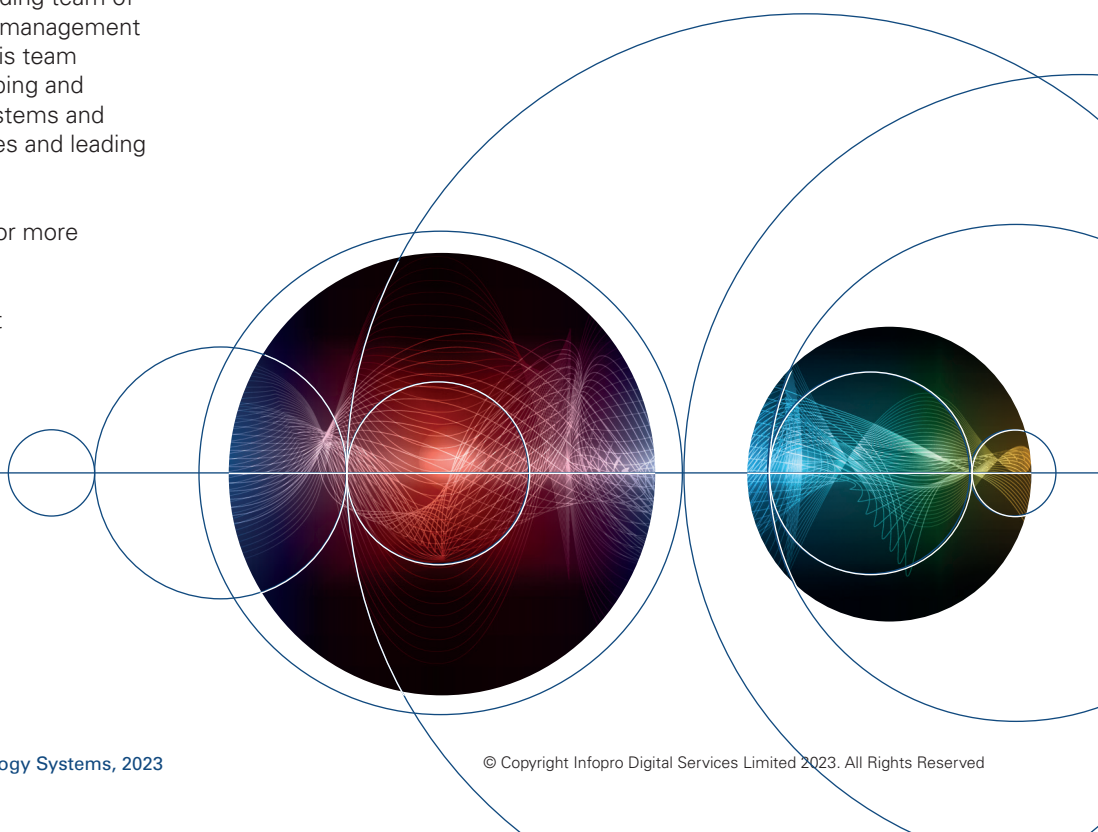


Table of contents

1. Report context	4
2. Quadrant context	7
3. Vendor context	15
4. Methodology	21

List of figures and tables

Figure 1: RiskTech Quadrant® for ALM solutions, 2023	8
Figure 2: RiskTech Quadrant® for FTP solutions, 2023	9
Figure 3: RiskTech Quadrant® for LRM solutions, 2023	10
Figure 4: RiskTech Quadrant® for capital and balance sheet optimization solutions, 2023	11
Figure 5: The benefits of SAS Asset and Liability Management	16
Figure 6: How SAS' asset and liability management helps	17
Figure 7: Sample configurable workflow	17
Figure 8: Model lifecycle management for integrated balance sheet risk management with SAS	18
Table 1: Completeness of offering – SAS (ALM solutions, 2023)	13
Table 2: Completeness of offering – SAS (FTP solutions, 2023)	13
Table 3: Completeness of offering – SAS (LRM solutions, 2023)	13
Table 4: Completeness of offering – SAS (capital and balance sheet optimization solutions, 2023)	14
Table 5: Market potential – SAS (ALM technology systems, 2023)	14
Table 6: SAS – company information	15
Table 7: SAS' ALM solutions – an integrated balance sheet risk management solution suite	19
Table 8: Evaluation criteria for Chartis' ALM technology systems, 2023 report	22

1. Report context

This vendor analysis is based on the Chartis quadrant report *ALM Technology Systems, 2023: Market Update and Vendor Landscape*. This section summarizes the key theses in that report; subsequent sections take a detailed look at the quadrant positioning and scoring for SAS, and Chartis' underlying opinion and analysis.

Key thesis

Since the last Chartis asset and liability management (ALM) **industry report in 2021**, the banking industry has faced substantial balance sheet challenges, triggered by ongoing volatility and uncertainty around interest rates. Liquidity risk has evolved into high-profile deposit outflows, with ensuing solvency incidents for institutions such as First Republic and Silicon Valley Bank (SVB). For more than a decade, the banking sector has operated in a low interest rate environment, with the last comparable surge in interest rates dating back to the 1980s. Current continued hikes in interest rates by central banks, as they battle persistent inflation, mark the end of the 'interest rate holiday' and the era of cheap money.

The ramifications of relaxed balance sheet rigor and investment approaches designed for lower, more stable interest rate regimes are already playing out in the mark-to-market losses for US banks. And the new interest rate environment is prompting a wide range of institutions – including those in the 'shadow banking' industry – to re-evaluate their ALM and investment strategies.

Given these new industry conditions and the evolving monetary environment, our latest research returns to the key themes highlighted by our 2021 industry report. We have re-evaluated the complex ALM framework, which broadly comprises distinct segments that include funds transfer pricing (FTP), liquidity risk management (LRM) and reporting, capital and balance sheet optimization, and ALM analytics and quantification. We examine the various challenges firms face as industry and regulatory standards push them to integrate their ALM operations and unify their ALM policies under a comprehensive internal strategy. Among the key trends we highlight is the renewed focus on LRM in the context of different types of institution and their specific liquidity dynamics. We also consider the adjacent focus on interest rate risk, including 'straightforward' interest rate risk.

In addition to our industry analysis, we also highlight trends in the regionally defined, fragmented vendor market. We explore the

different ALM requirements that emerge from varying perspectives within an institution, from the standpoint of both the asset-liability committee (ALCO) and the treasury department. We make the distinction between 'operational ALM', which focuses on day-to-day ALM calculations, and ALM from a trading and hedging perspective. We also note the approach to ALM that closely aligns with regulatory reporting and compliance and, in addition to regional trends, we highlight the institution types and product and balance sheet strategies that drive different ALM requirements. Finally, we consider these trends through both operational and technological lenses, to determine how financial institutions and the vendor landscape are evolving under new pressures.

Demand-side takeaways

Overview and context

ALM is a broad framework that comprises a complex set of interlocking analytical and operational activities. An essential part of ALM is the effective capture of liquidity requirements and interest rate sensitivities to inform funding decisions, as well as hedging and investment strategies. In essence, ALM is the process of managing and optimizing the assets and cashflows that financial institutions use to meet their obligations.

Since the 2008 financial crisis, however, ALM as a discipline has matured. Under the Basel era, the ALCO's oversight has become wider than ever, as banks' ALM programs encompass more and more integrated risks. Converging regulatory requirements, including credit accounting standards and capital requirements, are pushing banks to assign greater strategic importance to broader ALM programs. Despite the regulatory overhaul following the 2008 financial crisis and the emphasis on stress tests, the SVB incident more recently has caused regulators to take another look at the way aspects of the banking sector are governed. US regulators, in particular, are re-evaluating liquidity frameworks and insured deposit thresholds.

The confluence of factors that led to SVB's collapse – duration risk, treasury bond performance and deposit flight – has signaled to the industry that inadequate ALM can cause banking failures and considerable distrust among depositors and investors. More than ever before, banks are expected to forecast their short- and long-term cashflows and product strategies under a range of scenarios, including stressed conditions. With that expectation comes a focus on analytics and data management.

Firms are currently under pressure to implement robust performance attribution analytics and optimization methods for their portfolios and balance sheets. These advanced optimization strategies extend beyond simple income simulation, offering valuable insights into optimal strategies. However, it's worth noting that this area is relatively less mature within the ALM value chain.

The ALM analytics ecosystem is intricate, presenting challenging demands around integration. Despite this complexity, a diverse array of mathematical tools is becoming more accessible, empowering institutions to tackle these challenges effectively. As firms continue to refine their ALM processes, these tools will play a crucial role in enhancing their decision-making capabilities and helping them achieve optimal performance across their portfolios and balance sheets.

ALM in action: key market trends

Mathematical frameworks in ALM are becoming increasingly sophisticated

ALM practitioners are benefiting from a wider range of tools, including reverse stress testing, standardized and structured stress and scenario-generation mechanisms, and better cashflow and consolidation engines for the banking book. By being able to access detailed, granular cashflow for the banking book, firms can subject it to more effective and formal analytical techniques.

A broader recognition of interest rate risk on the balance sheet

Over the next 10 years, the banking industry will experience a period of greater interest rate volatility. A persistently low interest rate environment has put sustained pressure on banks' margins. Current high interest rates, however, are creating liquidity and capital issues, as banks' liability payments risk becoming greater than their asset earnings.

Chartis has identified the following high-level challenges that are emerging from this new environment:

- **Embedded leverage risk exists in a wide variety of locations**, such as the repurchase agreement (repo) market, elements of collateral, and non-banking institutions (including asset managers and pension funds). Exposure to these risks has already been seen in the market in the shape of the crisis in UK pension fund gilts, which has highlighted the issues with liability-driven investment (LDI).
- **Interest rate risk is embedded in a variety of products**, such as guaranteed products within the insurance industry.
- **Institutions** including retail banks, money market mutual funds and life insurance companies, as well as long-dated investment vehicles, **are exposed to customer behavior dynamics** that relate to interest rate risk. During higher interest rate periods, for instance, customers display an increasing unwillingness to hold long-dated assets, and shift toward the use of cash. These dynamics also emerge in areas such as bank loans that are made to wholesale institutions exposed to interest rate risk.

Increasing convergence in ALM across financial services

ALM is converging across the capital markets, banking and insurance sectors. Methodologies, mechanics and techniques differ, but cross-pollination between these sectors is causing these differences to lessen. The banking book, for example, looks at interest rate risk derived, analyzed and extracted from other markets. There are elements of convergence between the capital markets side and the banking-book side of a bank, while loan markets are now being reasonably priced by Current Expected Credit Losses (CECL) or International Financial Reporting Standard (IFRS) 9, both of which take a forward-looking view of risk management. Insurance ALM, particularly in the US, is becoming marketized and, in buy-side and insurance contexts, optimization tools are comparatively more mature.

Liquidity risk analysis will be a central feature of ALM

Chartis believes that, going forward, liquidity risk analysis will be a central feature of ALM. But it is important that regulators carefully consider the causes of the current crisis, rather than 'fighting

the last war'. The current issues in the market around liquidity risk are in some ways fundamental to the banking business model, and are inherent in interest rate transformation (such as converting short-dated rolling deposits into long-dated assets).

Supply-side takeaways

One key theme that Chartis has identified in the vendor landscape is consolidation among some of the leading vendors, which has been driven by general-purpose vendors acquiring specialists. As a result, some of the more analytics- and platform-oriented vendors have now incorporated considerable methodological capabilities, increasing the ability for sophisticated analysis and driving competition at the top end of the market. Considering the current market context, this consolidation is especially timely. There will be substantive evolution in the way financial institutions think about ALM, in terms of more sophisticated simulations, as well as more careful analysis of individual products and more focus on integrating product details, terms and conditions, and other elements.

This evolution brings the much-neglected interest rate risk in the banking book (IRRBB) to the fore. IRRBB needs to be expanded in a more sophisticated way to handle embedded risk options in the trading book and in all aspects of a bank's business. Non-banking institutions also have massive embedded interest rate risk profiles that need to be analyzed more carefully, especially given the expected interest rate volatility in the next five to 10 years.

Chartis recognizes the consolidation trend that is bringing methodology and platform together with general tool capacity and increasing the ability for sophisticated analysis. We have incorporated this as part of our scoring cycle.

The ALM vendor market – continued diversity and fragmentation

Despite this consolidation, it is important to recognize the variety of dimensions in which vendors continue to differentiate themselves – arguably, every major vendor has significantly different capabilities. This perspective is critical in understanding the vendor landscape and its continued diversity and fragmentation. Some of the differentiating dimensions include:

- The quality of behavioral analytics and modeling and risk aggregation for counterparties (including depositors).
- ALM metrics and ALM metrics attribution.
- Hedge analytics and balance sheet management (a financial perspective).
- Balance sheet management and optimization (an operational perspective).
- Extendibility/customization.
- Data and workflow integration.
- Scalable cashflow generation, which is important for many Asian institutions.
- Operational support and effective product pricing.
- Liquidity risk analytics.
- Regulatory focus and reporting.

2. Quadrant context

Introducing the Chartis RiskTech Quadrant®

This section of the report contains:

- The Chartis RiskTech Quadrants® for ALM, FTP, LRM and capital and balance sheet optimization solutions, 2023.
- An examination of SAS' positioning and scores as part of Chartis' analysis.
- A consideration of how the quadrants reflect the broader vendor landscape.

Summary information

What does the Chartis quadrant show?

Chartis' RiskTech Quadrant® uses a comprehensive methodology that involves 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 option as the best solution; rather it has a sophisticated ranking methodology to explain which solutions are best for specific buyers, depending on their implementation strategies.

The RiskTech Quadrant® is a proprietary methodology developed specifically for the risk technology marketplace. It takes into account vendors' product, technology and organizational capabilities. Section 4 of this report sets out the generic methodology and criteria used for the RiskTech Quadrant®.

How are quadrants used by technology buyers?

Chartis' RiskTech Quadrants® and FinTech Quadrants™ provide a view of the vendor landscape in a specific area of risk, financial and/or regulatory technology. We monitor the market to identify the strengths and weaknesses of different solutions and track the post-sales performance of companies selling and implementing these systems. Users and buyers can consult the quadrants as part of their wider research when considering the most appropriate solution for their needs.

Note, however, that Chartis does not endorse any vendor, product or service depicted in its research publications, nor does it advise technology users to select only those vendors with the highest ratings or other designation. Chartis' publications consist of the opinions of its research analysts and should not be construed as statements of fact.

How are quadrants used by technology vendors?

Technology vendors can use Chartis' quadrants to achieve several goals:

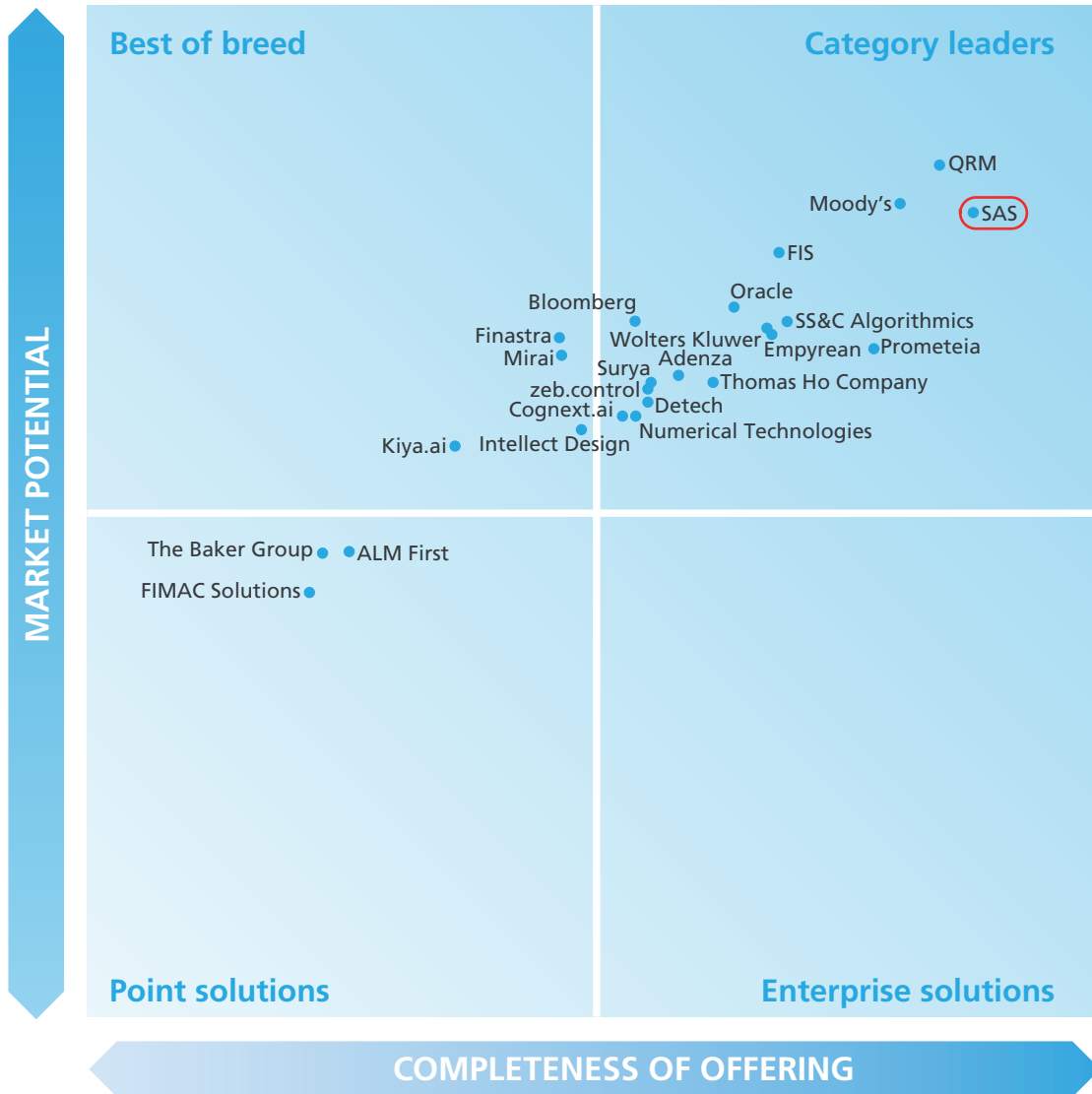
- Gain an independent analysis and view of the provider landscape in a specific area of risk, financial and/or regulatory technology.
- Assess their capabilities and market positioning against their competitors and other players in the space.
- Enhance their positioning with actual and potential clients and develop their go-to-market strategies.

In addition, Chartis' Vendor Analysis reports, like this one, offer detailed insight into specific vendors and their capabilities, with further analysis of their quadrant positioning and scoring.

Chartis Research RiskTech Quadrants® for ALM technology systems, 2023

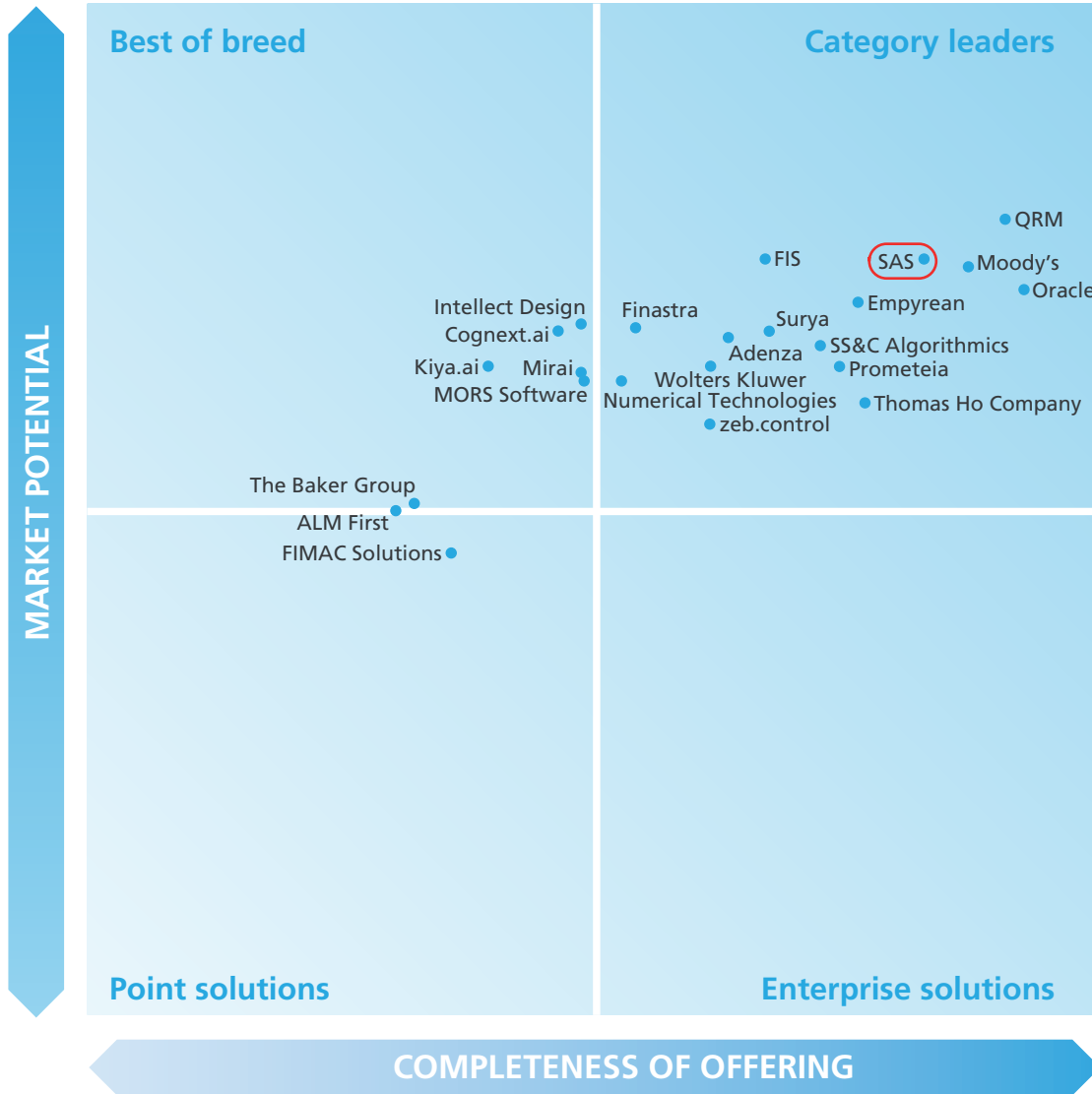
Figures 1 to 4 illustrate Chartis' view of the vendor landscape for ALM, FTP, LRM and capital and balance sheet optimization solutions, highlighting SAS.

Figure 1: RiskTech Quadrant® for ALM solutions, 2023



Source: Chartis Research

Figure 2: RiskTech Quadrant® for FTP solutions, 2023



Source: Chartis Research

Figure 3: RiskTech Quadrant® for LRM solutions, 2023



Source: Chartis Research

Figure 4: RiskTech Quadrant® for capital and balance sheet optimization solutions, 2023



Source: Chartis Research

Quadrant dynamics

General quadrant takeaways

Vendors in the ALM space are continuously evolving, as they strive to develop increasingly sophisticated tools that align with shifting market requirements. The nature and structure of ALM solutions vary significantly, and the different functionality offered by vendors is strongly influenced by the specific needs and regulations of the regions and institutions they serve.

The boundaries between different types of ALM solutions are not well-defined. The ALM landscape is diverse, containing vendors that offer specialized solutions tailored to specific needs. Some vendors,

for example, may concentrate their efforts on providing hedge/balance sheet management capabilities, which are vital for mitigating interest rate risk and optimizing balance sheet positions.

The focus on asset-backed securities in the US has resulted in a cluster of vendors that specialize in this area, and this requires a focus on ALM from a risk management, trading and hedging perspective. These vendors have extensive experience in assisting financial institutions in managing their mortgage-backed securities (MBS) portfolios. Such specialized vendors also provide support for interest rate management systems that approach the level of trading-quality analytics, equipping financial institutions with sophisticated

tools to manage interest rate risk effectively within their MBS holdings.

The four quadrants in Chartis' 2023 ALM report cover the broad ALM value chain, which requires distinct features and functionality. All of the quadrants display a range of vendors, including ALM vendors that focus on the requirements of the ALCO, as well as those that approach ALM from the perspective of the treasury department. (The ALM report distinguishes between 'operational ALM', which focuses on day-to-day ALM calculations, and ALM from a trading and hedging perspective.) The quadrants also feature specialist providers that provide specific analytics support, as well as vendors that closely align their ALM offerings with those for regulatory reporting and compliance.

The **ALM quadrant** serves as a comprehensive and all-encompassing category for ALM analytics, and brings together a diverse set of modeling frameworks and methodologies. The large proportion of vendors in the category leader section of the quadrant reflects the high-level maturity of the ALM space. Despite the level of competition, however, the ALM market remains highly fragmented, and market leaders vary by geography and institution type.

One key differentiator in the ALM quadrant is the sophistication of the analytics deployed by vendors. Other significant dynamics include the ability to link with capital market frameworks, credit risk integration, behavioral modeling sophistication, advanced interest rate modeling, accounting linkages between portfolios and the scalability of calculations.

The **FTP quadrant** covers an assortment of functions and processes, including funding, fund price calculation and allocation/attribution. The granular detail required at the product and transaction levels for effective FTP means that data management is a significant dynamic in the FTP quadrant, alongside hedging, product coverage and flexible calculation methodologies.

The **LRM quadrant** focuses on liquidity risk for Basel reporting for the net stable funding ratio (NSFR), liquidity coverage ratio (LCR) and internal liquidity adequacy assessment process (ILAAP). Liquidity risk is also viewed from a computational perspective in Chartis' ALM report. A significant dynamic of the LRM quadrant is the integration of data across different business silos and cashflow projections.

The **capital and balance sheet optimization quadrant** reflects a mix of vendors. Some specialize in optimization frameworks, while others have considerable expertise in financial planning and budgeting.

Vendor positioning in context – completeness of offering

ALM solutions

SAS' acquisition of Kamakura has raised the vendor's overall market presence and potential. The companies' combined features and functionality provide considerable benefits to their existing customers, giving the firms a competitive advantage in the market. SAS' customers can also benefit from integration with cloud-native solutions within the broader ALM ecosystem, including solutions for expected credit loss and regulatory capital. The acquisition of Kamakura's quantitative expertise coincides with a renewed focus on analytics among institutions, in the face of considerable long-term volatility.

SAS' best-in-class capability scores in interest rate and behavioral modeling reflect its expertise in advanced analytics. Its solution provides interest curve analytics and calculations for interest rate sensitivities, as well as a range of behavioral and prepayment models. SAS can provide firms with various views of the balance sheet, including run-off, static and dynamic views with incorporated business assumptions. The vendor also enables users to extend and customize their analytics.

SAS' strong ratings for capabilities and breadth of analytics, stress testing/reverse stress testing, simulation engine(s) capabilities, liquidity risk analytics and balance sheet analytics further highlight its strength in ALM analytics.

Table 1 shows Chartis’ rankings for the vendor’s coverage against each of the completeness of offering criteria.

FTP solutions

In the context of FTP, hedge management requires firms to develop appropriate hedges based on internal funding costs or fund transfer pricing. SAS achieved a particularly strong rating for its hedge management functionality, as it supports hedge-effectiveness analysis, hedge optimization and the development and analysis of hedging strategies. The vendor, which provides a range of broad risk-adjusted pricing analytics and profitability calculations, also received best-in-class ratings for simulation and pricing.

SAS provides models that can reflect a range of cashflow profiles, term structures and optionality. It supports cashflow projections across different economic and market scenarios, incorporating both contractual and behavioral cashflows.

Table 2 shows Chartis’ rankings for the vendor’s coverage against each of the completeness of offering criteria.

LRM solutions

One key aspect of SAS’ category leader position is its strength in data management, governance and integration – its high rating for integration in particular reflects its strong data integration capabilities, which are crucial for effective LRM. Also rating highly were its consistent cashflow generation frameworks, which are combined with a scalable cashflow engine.

Another competitive feature of SAS’ LRM offering is its ability to generate cashflows across business units, which can then be used to run scenario-based actions and optimizations within specific business and regulatory constraints. SAS also supports regulatory compliance for liquidity risk, including Basel liquidity ratios and European Banking Authority (EBA) liquidity classifications.

Table 3 shows Chartis’ rankings for the vendor’s coverage against each of the completeness of offering criteria.

Capital and balance sheet optimization solutions

The demand for dynamic and frequent optimization is growing, and the optimization value of managerial decisions within a regulatory context is a core dynamic of balance sheet optimization

Table 1: Completeness of offering – SAS (ALM solutions, 2023)

Completeness of offering criterion	Coverage
Capabilities and breadth of analytics	High
Scenario management systems (including specific ESG support)	Medium
Stress testing/reverse stress testing	High
Interest rate modeling	High
Simulation engine(s) capability	High
Liquidity risk analytics	High
Balance sheet analytics	High
Behavioral modeling	High
Data management	High
Integration capabilities	Medium

Source: Chartis Research

Table 2: Completeness of offering – SAS (FTP solutions, 2023)

Completeness of offering criterion	Coverage
Business line management	Medium
Hedge management	High
Simulation	High
Data management	Medium
Pricing	High

Source: Chartis Research

Table 3: Completeness of offering – SAS (LRM solutions, 2023)

Completeness of offering criterion	Coverage
Scenario generation	Low
Cashflow projections	High
Integration capabilities	High
Reporting	High
LCR + NSFR	High

Source: Chartis Research

processes. SAS offers a range of simulation and mathematical optimization approaches and techniques. Its category leader position also reflects the scalability of its platform and the combination of both SAS' and Kamakura's optimization offerings.

The vendor's flexibility and scalability in handling diverse types of data enables firms to conduct dynamic and frequent optimizations using a variety of methods. SAS also provides a financial planning and forecasting engine, enabling users to plan allocations across different business hierarchies and market conditions.

SAS supports firms' scenario-based analysis of the balance sheet across various market and risk factors, so they can assess impacts on factors such as liquidity, capital, interest rates and funding. Users can define risk factor features and scenarios and shocks, which can also be imported from external sources. Balance sheet optimization objectives and constraints can also be defined by users across multiple periods.

Table 4 shows Chartis' rankings for the vendor's coverage against each of the completeness of offering criteria.

Vendor positioning in context – market potential

SAS' strength in providing analytics support for a variety of specifications within a complex and ever-changing regulatory environment contributes significantly to its market potential in the financial services industry. The diverse array of modeling approaches it offers to financial institutions is another key feature of its strong market presence, giving firms the flexibility to gain a better understanding of the impact of different factors on their income statements and balance sheets.

In the context of ongoing market volatility, financial institutions face challenges in managing their business models effectively. SAS' integrated approach can help financial institutions to develop a holistic view of their risk exposure, make informed decisions, and optimize their capital allocation to withstand market uncertainties.

Moreover, SAS' ongoing investment and research emphasize the strategic potential of its recent initiatives. Its powerful optimization engine, for example, is a vital component of its ALM presence, while its ability to provide sophisticated tools for better pricing, risk management and decision-making, and a robust suite of analytics

Table 4: Completeness of offering – SAS (capital and balance sheet optimization solutions, 2023)

Completeness of offering criterion	Coverage
Breadth of asset class/business line coverage	Medium
Optimization engine	High
Scenario and simulation frameworks	High
Data management	High
Business planning and analysis	High

Source: Chartis Research

tools tailored to regulatory demands, has helped to make it a market leader.

Its provision of Kamakura's robust ALM capabilities alongside its own expertise and experience make for a strong combination, allowing firms to use a unified platform that can seamlessly integrate ALM functions, risk management and advanced analytics. And the continued integration of Kamakura's expertise in areas such as FTP will help to expand and enhance an already solid market presence.

Table 5 shows Chartis' rankings for the vendor's coverage against each of the market potential criteria.

Table 5: Market potential – SAS (ALM technology systems, 2023)

Market potential criterion	Coverage
Customer satisfaction	High
Market penetration	High
Growth strategy	High
Business model	High
Financials	High

Source: Chartis Research

3. Vendor context

Overview of relevant solutions/ capabilities

Table 6 provides a summary of the vendor and its solutions.

SAS Asset and Liability Management

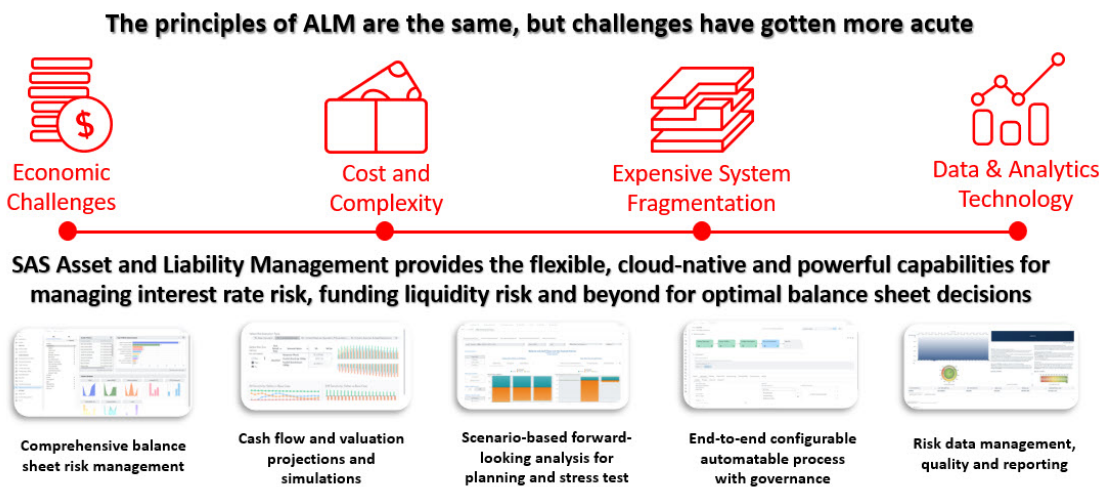
The economic environment of the COVID-19 pandemic, and the post-pandemic era, have been particularly challenging for financial institutions in their balance sheet risk management, in particular

Table 6: SAS – company information

Company	SAS
Headquarters	Cary, NC, US
Other offices	Total number of countries where SAS has R&D offices: 7 (US, UK, China, Denmark, India, Japan, Republic of Korea). Total number of countries where SAS has offices: 56. Total number of SAS regional offices in the US: 12 in 10 states. Total number of SAS offices in the US (including executive suites and training centers): 44 in 20 states.
Description	SAS’ continued development of next-generation risk solutions will emphasize a cloud- and application programming interface (API)-first architecture based on SAS Viya 4, an artificial intelligence (AI), analytics and data management platform. With more than 40 years’ experience in analytics and business intelligence (BI) software, and 30 years’ experience in enterprise risk management solutions and practice, SAS aims to use its risk expertise, cutting-edge analytics and reporting technology to help clients analyze and manage integrated balance sheet risk.
Solution(s)	<p>SAS has a long history of research, solutions and practices in balance sheet risk management, covering:</p> <ul style="list-style-type: none"> • Open, scalable technology for granular and timely analyses. • Leading risk analytics backed by SAS’ analytical power and quantitative risk research. • Cutting-edge SAS enterprise analytics and BI platform. • Interest rate and credit spread curve analytics. • Out-of-the-box financial product cashflow and valuation modeling. • Comprehensive functionalities across ALM, liquidity risk, FTP, market and credit risk. • Market, credit and behavioral modeling. • Multi-period balance sheet dynamics for stress testing and simulations. • Flexible risk aggregation and reporting for insightful integrated risk. • Data integration and quality checks. • Process automation and governance. • Third-party models and collaborations.

Source: SAS

Figure 5: The benefits of SAS Asset and Liability Management



Source: SAS

because of stresses on interest rates, asset values and behavioral modeling. The mini banking crisis in March 2023 disturbed a period of relative calm in the financial services industry. At the same time, the rapid development of data and analytics technology has introduced considerable challenges and opportunities to the industry, especially in the adoption of machine learning (ML), AI, digitalization and the cloud (see Figure 5).

Over the past decade, forward-thinking institutions have been developing their balance sheet integration, driven by risk data aggregation and reporting, stress testing and other scenario-based risk and finance initiatives such as IFRS 9 and CECL. The question now, however, is whether that is enough. In particular, institutions in the industry are facing the following key questions:

- Does balance sheet risk management align with their business models?
- Are ALM and liquidity risk analysis capabilities rich and flexible enough to provide timely and comprehensive information to executives and board members?
- Can yield curve analytics and behavioral models be applied consistently at a granular level for insightful bottom-up analysis?
- How can management encourage effective collaboration and accountability?

SAS' risk solutions provide comprehensive balance sheet risk management on a modern, cloud-native, scalable technology platform that offers timeliness, agility, flexibility and granularity. As an industry-leading analytics solution provider, SAS has worked

with financial institutions of all sizes to address their most pressing analytical challenges across risk and finance functions.

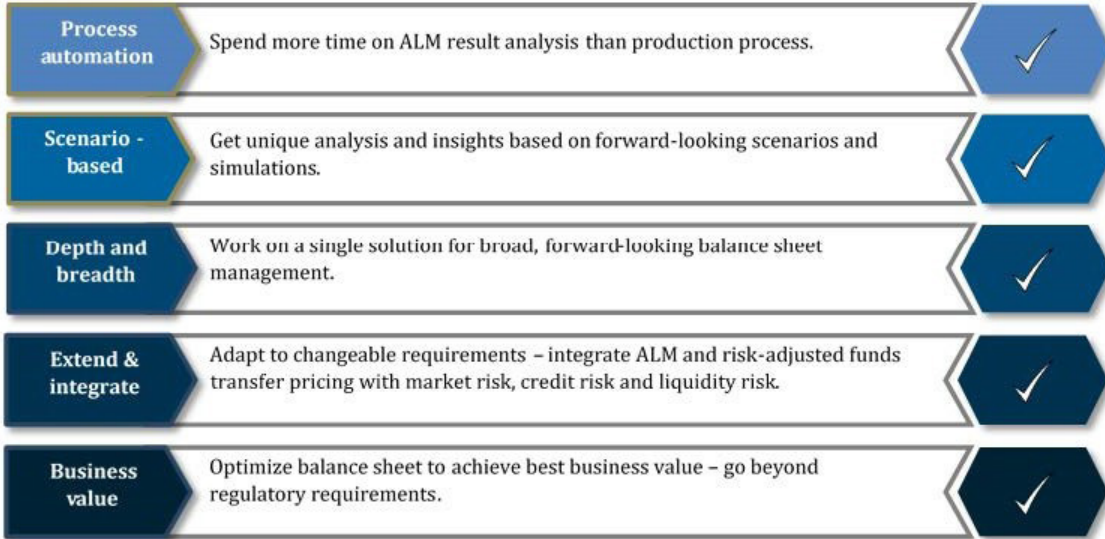
Modern technology and a best-in-class analytics platform

SAS is a long-standing partner of leading financial institutions, including global systemically important banks (G-SIBs). SAS' ALM solutions provide a broad range of integrated capabilities in data management, modeling, simulation and reporting, supported by the highly scalable power of cloud-native computing technology (see Figure 6 on page 17).

A scalable, adaptive architecture

SAS' ALM solutions are delivered on a modern, cloud-native Kubernetes architecture that is highly scalable, embracing fast integration and deployment to accommodate different levels of sophistication and infrastructure usage. The scalability allows timely delivery of the detailed results of analyses with manageable infrastructure cost. The solution can work on cloud-based and on-premises traditional infrastructures.

Figure 6: How SAS’ asset and liability management helps



Source: SAS

End-to-end process management and governance

The solution comes with an institution-configurable workflow framework (see Figure 7) in which end-to-end analysis processes can be defined for the standardization, governance and containerization of analysis artifacts. This helps to add transparency and support internal and external scrutiny. A particular version of configuration and code base can be incorporated with each of these processes via, for example, a Git repository. Each process can allow multiple iterations and analysis runs. User actions, iterations, task status, approval and sign-offs are logged and accessible in the graphical user interface (GUI). In the increasingly scrutinized risk management environment, this functionality adds value to transparency and governance for every analysis cycle. Multiple jurisdiction support, business-line and entity-specific configurations and sandbox environments can be easily set up with specific analysis cycles in the same deployment, with clear governance.

Robust data management capabilities

SAS’ ALM solutions come with a predefined, yet extendable, data model to make data onboarding easier. SAS’ data management tool provides a flow of data loading, extraction and transformation

capabilities for transparency, on-screen data mapping and lineage. SAS also provides connection tools to a wide selection of data platforms for data integration. Client institutions can also choose their own preferred data onboarding. ALM analysis-specific data validation and adjustment/correction rules can be specified in the solutions. SAS also advocates Basel risk data aggregation and reporting principles.

Insightful risk reporting and visual analytics

Risk monitoring and reporting on SAS’ fully integrated, open and cloud-native AI and analytics platform give users insight and understanding, based on the results of analysis from the ALM solutions and other systems. The end-to-end process enables the timely availability of granular data for on-demand slice-dice, filtering and drill-down of the information. Regardless of role, every user of the system can be empowered with specifically configured and securely deployed reports.

Integration with risk modeling and model risk

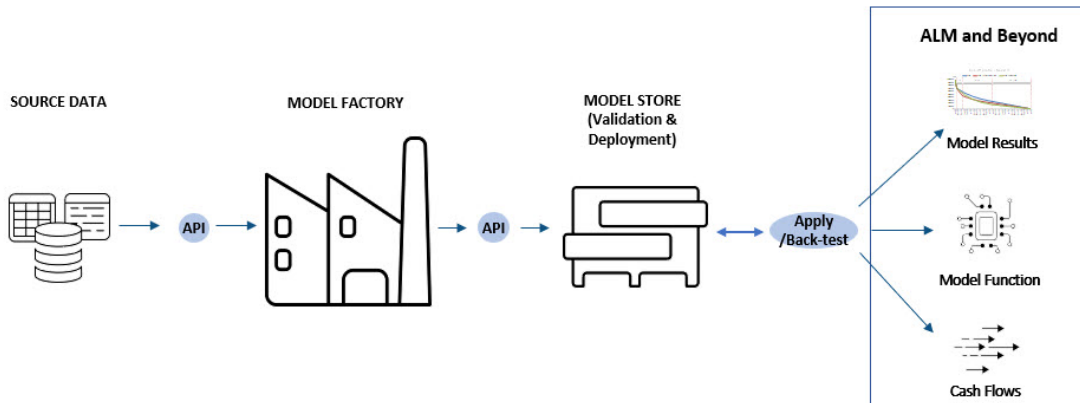
The demand for analytical models for both market rates and customer or counterparty behavior is increasing significantly. An important aspect of

Figure 7: Sample configurable workflow



Source: SAS

Figure 8: Model lifecycle management for integrated balance sheet risk management with SAS



Source: SAS

integrated balance sheet risk management is facilitating the consistent application and efficient management of risk model lifecycles. In addition to standard analytics capabilities (from generalized linear time series to ML models) that are already included in SAS' ALM solutions, users can also choose to leverage SAS' risk modeling and model management solutions to better manage the model lifecycle throughout the ALM applications (see Figure 8).

Comprehensive functionality

SAS' ALM solutions are developed for integrated balance sheet risk management to support the increasingly important role of the ALM function in financial institutions (see Table 7 on page 20). The solution provides comprehensive and advanced functionality based on SAS' sophisticated analytics and risk thought leadership.

Lessons learned from the last financial crisis have been the main catalysts so far for the modernization of balance sheet risk management. This evolution has been driven by supervisory requirements, including regulatory stress testing, LRM requirements (e.g., LCR, NFSR and asset encumbrance), IRRBB and recovery and resolution planning. Data integration and technological advances have also been instrumental. SAS' mission is to help client institutions build a proper balance sheet risk management infrastructure beyond regulatory compliance, to ensure that they can withstand various economic conditions.

Holistic scenario-based balance sheet risk management

While traditional ALM and LRM typically assume static run-off or a constant balance sheet, this practice creates a disconnect between financial

planning and enterprise stress testing. SAS' ALM solutions support forward-looking balance sheet risk management using dynamic business evolution assumptions that are conditioned on a range of plausible scenarios. The solution also provides tools to support reverse stress testing and long-duration analysis required for areas such as climate risk modeling.

SAS' solutions are architected to support granular cashflow and valuation modeling and analysis and, as a result, users can apply various segmentation and modeling techniques with risk correlations. For example, given that interest rates do not act alone, an integrated risk management approach should analyze the joint impact of interest rate risk and foreign exchange, as well as market and credit risk. Firms must consider both macro and micro perspectives of these risks and, more importantly, apply them consistently to business volume projections, as well as cashflows and value projections in a future with multiple horizons.

Advanced rate analytics

In the past decade there has been wide variation in interest rate dynamics. After a long run of ultra-low or even negative rates, we have entered an inflationary period with rapidly rising rates and greater future uncertainty. This uncertainty is not only reflected in the level and volatility of short-term rates but also in the shape of the yield curve. For a balance sheet covering multiple economic regions, the rate uncertainty also creates considerable imparity. This unsettled environment, along with the Interbank Offered Rate (IBOR) transition, demands a more sophisticated approach to rate analytics. A stochastic, simulation-driven multifactor model, such as the Heath-Jarrow-Morton model for the efficacy of rate analytics, allows banks' balance sheet risk management to

Table 7: SAS' ALM solutions – an integrated balance sheet risk management solution suite

Cash flow modeling and valuation	<ul style="list-style-type: none"> • Flexible risk factor, curve and group configuration for any market, macroeconomic and institution-specific risk assumptions and models. • Coverage of a wide range of banking book and trading book products with advanced out-of-the-box methodology. • Yield curve smoothing and modeling for both interest rate and credit spreads. • Flexible, forward-looking credit and behavioral modeling.
Asset and liability management and liquidity risk management	<ul style="list-style-type: none"> • Extensive standard and advanced analytics for interest rate risk, earnings risk and economic value of equity. Incorporates basis, spreads, repricing and embedded option risks. • Modified, effective and partial duration analysis. • Bottom-up cashflow and repricing risk projection and gap analysis at a granular level. • Stress testing and simulation with multi-period dynamic balance sheet assumptions.
Market risk management	<ul style="list-style-type: none"> • Advanced market risk methodologies that allow users to apply scenario, sensitivity and simulation analyses of portfolio valuation, P&L and accounting. • Out-of-the-box and configurable risk metrics. • Risk grouping and attribution.
Funds transfer pricing	<ul style="list-style-type: none"> • FTP rate calculation and forecasting capability to help measure risk-adjusted performances. • A wide spectrum of standard FTP methods. • Multiple risks, including embedded options, accounted for. • Forward-looking FTP projections with impact on net interest income (NII).
Regulatory and compliance	<ul style="list-style-type: none"> • Interest rate risk in the banking book (IRRBB) coverage of standardized and internal model approaches, as well as supervisory outlier tests. • Basel liquidity risk ratios – liquidity coverage ratio (LCR) and net stable funding ratio (NSFR). • Minimum capital requirement for market risk (Fundamental Review of the Trading Book [FRTB]). • Fair valuation and expected credit loss.
Balance sheet dynamics and optimization	<ul style="list-style-type: none"> • Balance sheet segmentation, modeling and rule-based rebalancing. • Support for scenario-based balance sheet evolution modeling, for business-as-usual and stress scenario planning and hedging strategies. • Run-off, static and changing volume with new business, rollover and reinvestment, and their impact across valuation and profitability. • Leveraging SAS' optimization analytics on balance sheet planning and hedging strategies.

Source: SAS

remain adaptive. To address this sophistication, SAS' ALM solutions provide out-of-the-box rate and curve analytics.

Credit and behavioral modeling and beyond

Credit risk models (whether operating through credit spreads implied by the market prices of traded credits or the probability of default and loss given default) can be flexibly specified or modeled in SAS' ALM solutions. This enables firms to develop cashflow and valuation projections based on both static and dynamic scenarios. Depending on the modeling approach and business applications employed, the modeled credit risk should duly reflect the point-in-time or through-the-cycle nature of the risk. For many use cases, a more dynamic transition-model framework can prove more robust and forward-looking. SAS' ALM solutions are intimately connected with SAS' Kamakura Risk Information Services (KRIS), which are used by a large group of central banks, banks and other financial services companies all over the world.

Similarly, cashflow and valuation projections should accommodate the behavioral models used to capture deposit decay, limit utilization, prepayment or curtailment and other optionalities embedded in the products or market instruments on the balance sheet.

While modeling analytics must be robust enough to support the existing modeling framework, they should also support emerging AI and ML approaches. Enabling 'champion and challenger' and 'what if' capabilities is critical in a volatile economic environment. The consistency of credit and behavioral model application across balance sheet risk management and regulatory and risk-based accounting standards is a vital requirement for effective risk management and reporting efficacy.

Risk analytics and technology expertise

SAS' 40-year experience in analytics and technology is backed by its heavy investment in research and development and its close collaboration with customers. SAS' risk solution team comprises a group of researchers and professionals with long academic and industry records.

Research and thought leadership

SAS has served the analytics, data management and reporting needs of the financial services industry for more than 40 years, and its platform and risk solutions incorporate cutting-edge, research-backed results.

Customer advocacy

SAS builds long-term partnerships with its customers via its products and services. Solution documentation, education and technical support are the integral components of its success with customers. The company's offices and training centers in many regions and countries are staffed with risk, solution and technical consultants who understand local regulations and business environments, and who have deep solution knowledge for fast and localized support.

A constructive network of partners

SAS' carefully selected business consulting and IT partner networks bring the added benefits of expanded knowledge and support capabilities to customers. They also allow customers to support their preferred business consultants and technical infrastructure vendors with SAS solution implementations.

4. Methodology

Overview

Chartis is a research and advisory firm that provides technology and business advice to the global financial services 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® and FinTech Quadrant™ reports are written by experienced analysts with hands-on experience of selecting, developing and implementing financial technology solutions for a variety of international companies in a range of industries, including banking, insurance and capital markets. The findings and analyses in our quadrant reports reflect our analysts' considered opinions, along with research into market trends, participants, expenditure patterns and best practices.

Chartis seeks to include RiskTech and FinTech vendors that have a significant presence in a target market. The significance may be due to market penetration (e.g., a large client base) or innovative solutions. Chartis uses detailed vendor evaluation forms and briefing sessions to collect information about each vendor. If a vendor chooses not to respond to a request for information, Chartis may still include the vendor in the report. Should this happen, Chartis will base its opinion on direct data collated from technology buyers and users, and from publicly available sources.

Chartis' research clients include leading financial services firms and Fortune 500 companies, leading consulting firms and financial technology vendors. The vendors evaluated in our quadrant reports can be Chartis clients or firms with whom Chartis has no relationship.

Chartis evaluates all vendors using consistent and objective criteria, regardless of whether they are Chartis clients. Chartis does not give preference to its own clients and does not request compensation for inclusion in a quadrant report, nor can vendors influence Chartis' opinion.

Briefing process

We conduct face-to-face and/or web-based briefings with each vendor.¹ During these

¹ Note that vendors do not always respond to requests for briefings; they may also choose not to participate in the briefings for a particular report.

sessions, Chartis experts ask in-depth, challenging questions to establish the real strengths and weaknesses of each vendor. Vendors provide Chartis with:

- A business update – an overview of solution sales and client satisfaction.
- A product update – an overview of relevant solutions and R&D roadmaps.
- A product demonstration – key differentiators of their solutions relative to those of their competitors.

In addition to briefings, Chartis uses other third-party sources of data, such as conferences, academic and regulatory studies, and publicly available information.

Evaluation criteria

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. The specific criteria used for ALM technology systems are shown in Table 8 (on page 23).

Completeness of offering

- **Depth of functionality.** The level of sophistication and number 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 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 can vary for each subject area, but special attention is given to functionality covering regulatory requirements,

Table 8: Evaluation criteria for Chartis' ALM technology systems, 2023 report

Completeness of offering	Market potential
ALM	Customer satisfaction
Capabilities and breadth of analytics	Market penetration
Scenario management systems (including specific ESG support)	Growth strategy
Stress testing/reverse stress testing	Business model
Interest rate modeling	Financials
Simulation engine(s) capability	
Liquidity risk analytics	
Balance sheet analytics	
Behavioral modeling	
Data management	
Integration capabilities	
FTP	
Business line management	
Hedge management	
Simulation	
Data management	
Pricing	
LRM	
Scenario generation	
Cashflow projections	
Integration capabilities	
Reporting	
LCR + NSFR	
Capital and balance sheet optimization	
Breadth of asset class/business line coverage	
Optimization engine	
Scenario and simulation frameworks	
Data management	
Business planning and analysis	

Source: Chartis Research

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 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 and 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 construction process

Chartis constructs its quadrants after assigning scores to vendors for each component of the completeness of offering and market potential criteria. By aggregating these values, we produce total scores for each vendor on both axes, which are used to place the vendor on the quadrant.

Definition of quadrant boxes

Chartis' quadrant reports do not simply describe one technology option as the best solution in a particular area. Our ranking methodology is designed to highlight which solutions are best for specific buyers, depending on the technology they need and the implementation strategy they plan to adopt. Vendors that appear in each quadrant have characteristics and strengths that make them especially suited to that category and, by extension, to particular users' needs.

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 business intelligence (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.
- Because of their focused functionality, best-of-breed solutions will often be packaged together as part of a comprehensive enterprise risk technology architecture, co-existing with other solutions.

Enterprise solutions

- Enterprise solution 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 typically are 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.
- They 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.
- They typically will benefit from strong brand awareness, a global reach and strong alliance strategies with leading consulting firms and systems integrators.

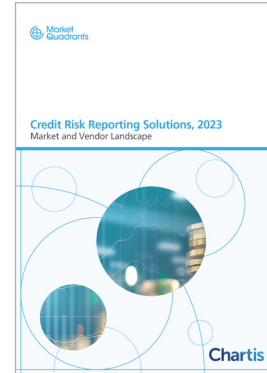
Further reading



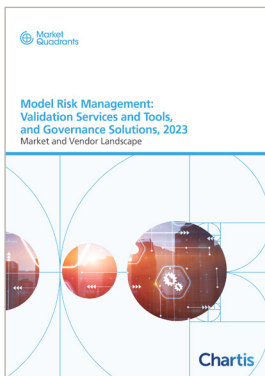
ALM Technology Systems, 2023: Market Update and Vendor Landscape



ALM Technology Systems, 2021: Market and Vendor Landscape



Credit Risk Reporting Solutions, 2023: Market and Vendor Landscape



Model Risk Management: Validation Services and Tools, and Governance Solutions, 2023: Market and Vendor Landscape



Actuarial Modeling and Financial Planning Systems, 2022: Market and Vendor Landscape



RiskTech 100 2023

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