Market Quadrants

Pricing and Valuation Systems, 2024

Market and Vendor Landscape

Chartis

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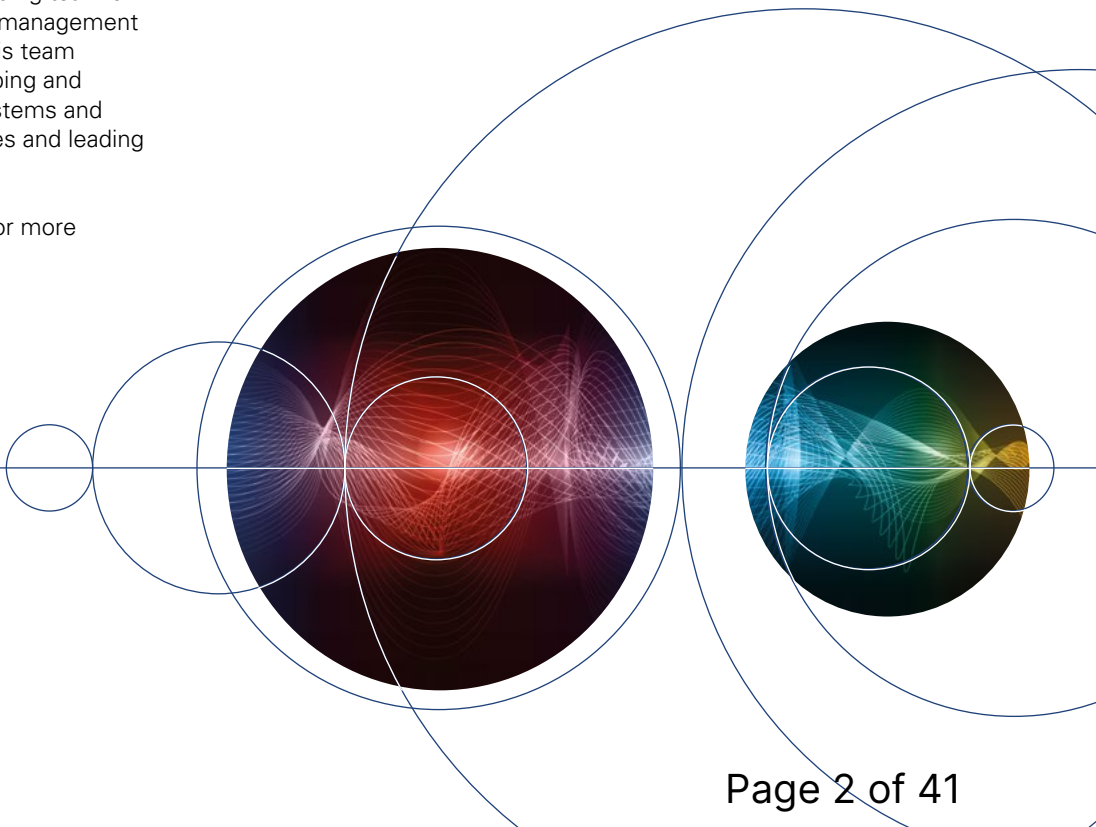

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Market Quadrants Report

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Executive summary

As the derivatives, securitization and fixed-income markets have matured, financial products have expanded significantly in complexity and range, and now require equally sophisticated pricing frameworks. Today, pricing systems have evolved into an engineering discipline characterized by established best practices, design choices and structural intermediates. Modern pricing libraries, including open-source variants, now support a wide array of programming styles, cashflow scripting languages and performance optimization techniques.

Despite this advanced state, however, true cross-asset pricing systems remain relatively uncommon, reflecting the unique requirements of different product markets. Integrated pricing and risk systems must cover a diverse array of pricing models and risk calculations, tailored to the specific characteristics of various financial instruments. Interest rate derivatives, residential mortgage-backed securities (RMBS), foreign exchange and equity derivatives are influenced by distinct market dynamics and continue to support distinct software ecosystems.

This report evaluates the comprehensive landscape of pricing and valuation systems, considering the unique demands of different financial assets, as well as their market dynamics and interdependencies. In it, we examine the technological architecture underpinning the different pricing frameworks and identify the key drivers of their evolution. We also explore the evolution and changing market structures of different asset classes.

To extend our analysis, Chartis' forthcoming report, *Analytical Accelerators and Tools, 2024: Market and Vendor Landscape*, will explore the evolution of payoff scripting languages in computational finance, the development of adjoint algorithmic differentiation (AAD) approaches, and the uptake of machine learning (ML) for function approximation in pricing and risk systems.

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 solutions can meet an organization's needs. The RiskTech Quadrant® does not simply describe one solution as the best; rather, it has a sophisticated ranking methodology that shows which solutions would be best for buyers, depending on their implementation strategies.

This report covers the following providers of pricing and valuation systems:[1] Acadia, Aladdin by BlackRock, Andrew Davidson & Co., Bloomberg, Cboe, CloudAttribution, CME Group, Confluence, Everix, Finastra, Finmechanics, FIS, ICE Data Services, Intex, ION, ITO33, LSEG, MathWorks, MIAC Analytics, Moody's, MSCI, Murex, Nasdaq, Numerix, PortfolioScience, RiskSpan, S&P Global, SAS, Savvysoft, Solytics Partners, Suite LLC, TechHackers, Thetica Systems, Torstone Technology, Trepp, UnRisk, Vichara, Vola Dynamics and Wilshire.

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.

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Market landscape

Market evolution: understanding new structures, conditions and requirements

The era of post-COVID pandemic recovery has been marked by significant financial market volatility, driven by such factors as banking failures in the US in 2023, geopolitical events and widespread monetary tightening policies. The new interest rate environment, characterized by aggressive

rate hikes by central banks aimed at combating soaring inflation, presents challenges to existing curve analytics and stochastic volatility models. Notably, the US yield curve inverted in late 2019 and short-term rates surpassed long-term ones, a phenomenon not seen since the 2008 financial crisis and often regarded as a precursor to an economic recession.

In this context, the calibration and curve fitting of pricing libraries, which rely on a range of analytical methods – including numerical methods, partial differential equations (PDEs) and such pricing models as Black-Scholes, Hull-White and Monte Carlo simulations – are becoming increasingly complex. In the second half of 2022, the gross market value of over-the-counter (OTC) derivatives grew by 13%, **reaching $20.7 trillion dollars**. Amid rising interest rates and inflation, a key force behind this growth was the presence of interest rate derivatives.

Market volatility is also reshaping the structure of various financial markets and altering product dynamics. Factors such as higher interest rates, banking failures and post-crash regulations have contributed to the growth of certain asset classes, notably private credit. The Bank of England (BoE) estimates that the private credit market may have grown by 300% since 2015, reaching approximately **$1.8 trillion globally**. The BoE also notes that this approximation may be conservative due to the limited availability of private credit data. The lack of transparency and market data complicates the pricing of illiquid private debt, which often requires subjective valuation models.

Rising interest rates and heightened market volatility have significantly bolstered growth in the annuities market. Savers seeking stable income amid uncertain conditions are increasingly turning to annuities, which now offer substantially improved rates. Similarly, convertible bonds are experiencing robust growth, gaining popularity as issuers seek alternative financing options. Although the appeal of convertible bonds waned during the pandemic due to depressed equity prices, the recent surge in interest rates has reignited their attractiveness. Currently, US issuance dominates this market, with artificial intelligence (AI) firms capturing considerable attention.

This evolving financial landscape underscores the necessity for advanced analytical tools and models to navigate the complexities posed by increased market volatility and shifting financial structures. Computational performance is a critical element of pricing complex derivatives and running

simulations. Pricing libraries are built using such techniques as vectorization, parallelization and graphics processing unit (GPU) acceleration to improve computational performance.

The asset landscape

In the following sections, we consider the market areas and asset classes covered in this report, assessing the capabilities of the pricing and valuation tools for each and, where appropriate, identifying any notable trends in their development and use.

Integrated pricing and risk management

Integrated pricing and risk management is a comprehensive approach to valuing financial instruments and managing the associated risks. It involves using quantitative models and techniques to price various financial products, while considering such factors as market risk, sensitivities and performance attribution. In volatile markets, the main challenge to integrated pricing and risk management systems is flexibility, defined here as the rapid ability to respond to new products, add measures and create new dashboards. Systems need to be able to respond to rapidly changing market conditions, including huge growth in certain products and new client demands. Flexible and modifiable systems enable users to access historical data easily and generate calculations to address new risk demands and product dimensions (such as credit spreads or volatility smiles). Functional requirements include:

- Real-time position keeping (P&L).
- Different types of stress testing and scenarios.
- Greeks and sensitivities.
- Limit rules and checks.
- Performance attribution.
- ‘What-if’ analysis.
- Cashflow testing.

Fixed-income products

In this report, ‘fixed income’ refers to debt instruments or securities that pay a fixed rate of interest, or coupon payments over a specified period.

Examples include municipal bonds, treasury bonds, convertible bonds, structured notes and other debt instruments issued by governments and corporations.

Technical requirements include:

- Yield curve construction.
- Curve fitting/smoothing.
- Credit spreads and default risk.
- Present value and discount rate.
- Embedded options.
- Macroeconomic factors.
- Reference data.

Market trends

The scale of the fixed-income market underscores its critical role within the financial ecosystem, serving as a vital source of capital for both governments and corporations. The size and depth of this market provide the necessary conditions (in terms of liquidity and stability) for economic growth and financial stability. However, recent market volatility has highlighted the bond market's liquidity, which is a key concern for central banks.

The transition from a prolonged low-interest-rate environment to a period of significant volatility and higher interest rates has fundamentally reshaped the dynamics of the bond market. Rapidly rising yields have inversely impacted bond prices and contributed to multiple liquidity events, including the Silicon Valley Bank and UK gilt crises. These incidents underscore the sensitivity of bond market liquidity to broader economic shifts and the critical role of central bank policies.

The structure and performance of the fixed-income market are closely linked to the policy responses of central banks to persistent inflation. The Federal Reserve's recent interest rate hikes, aimed at combating high 'sticky' inflation, have driven government bond yields to levels not seen since the 2008 financial crisis. These policy moves are intended to stabilize prices, but also have significant implications for bond valuations and market liquidity. The Fed is currently embarking on a bond buyback program, for the

first time since 2002, with the aim of improving liquidity and stability in the world's biggest bond market. The US government deficit is also driving substantial volatility in the US Treasury market.

Beyond its sheer size, the fixed-income market is also distinguished by the diversity of its product segments. These include government bonds, corporate bonds and various types of structured product. Each segment has unique characteristics and trading mechanisms. Sovereign bond futures, for example, primarily trade on electronic platforms, which offer efficiency and transparency. In contrast, while electronic trading has grown in investment-grade corporate bonds, much of the trading in corporate bonds remains dealer-oriented, reflecting the bespoke nature of many corporate bond transactions.

Interest rate derivatives (IRDs)

IRDs are derivatives based on an underlying interest rate index, and are often used for hedging or speculation on future interest rate movements. Examples include interest rate swaps, forward rate agreements (FRAs), interest rate options and interest rate futures.

Technical requirements include: industrialization, standardization and domain-specific languages.

Market trends

The transition from the London Inter-Bank Offered Rate (LIBOR) to 'nearly' risk-free rates (RFRs) has markedly transformed the product composition of the market for OTC IRDs. This paradigm shift has rendered some traditional hedging instruments largely obsolete, specifically those used to mitigate the 'fixing risk' associated with LIBOR rate mismatches across different contract maturities. A prime example is FRAs, which were widely used for hedging against fixing risk. Between 2019 and 2022, the turnover volume of FRAs **plummeted by approximately 75%**.

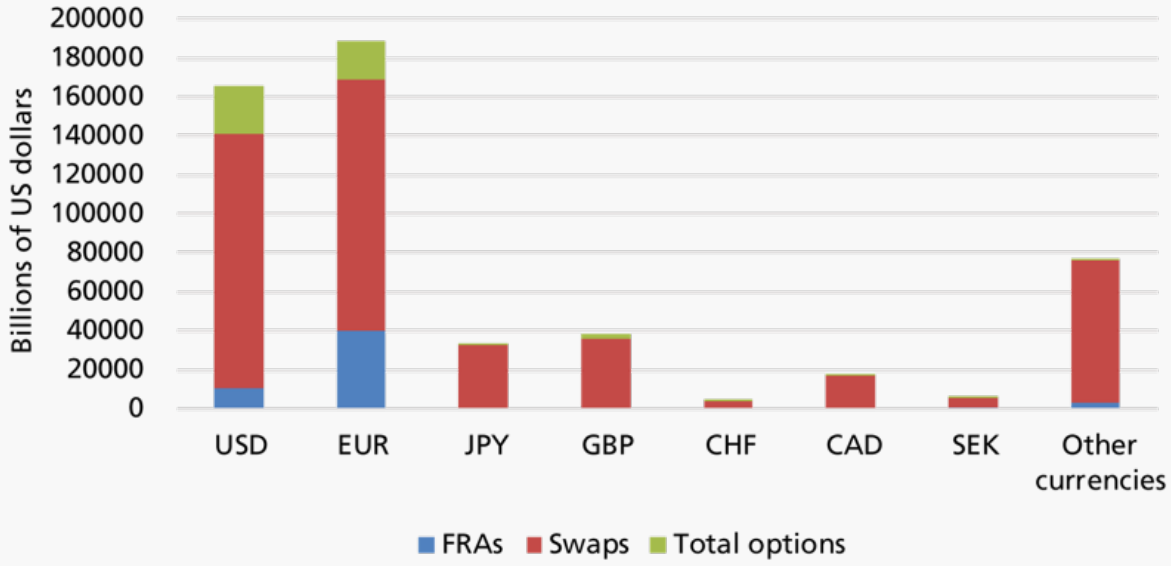
This significant decline in FRAs mirrored broader market trends, as the global turnover of IRDs **contracted by about 20%** during the same time frame. The movement away from LIBOR toward such RFRs as the Secured Overnight Financing Rate (SOFR), the Sterling Overnight Index Average (SONIA) and the Euro Short-Term Rate (€STR) requires changes in hedging strategies, and spurred the development of new financial instruments tailored to these more stable benchmarks.

In 2022, the financial landscape was further reshaped by high global inflation, which catalyzed a new interest rate environment. As central banks raised interest rates to combat inflation, the gross market value of IRD contracts increased, reflecting the disparity between the new rates and those at the contracts' inception. Specifically, euro IRDs saw a 23% rise in the second half of 2022, following a 37% increase in the first half of the year. US dollar IRDs also **experienced respective increases** of 40% and 30% in the first and second halves of 2022.

Global market context

For context, Figure 1 illustrates the market dominance of the US dollar and the euro. The high proportion of swaps across currencies highlights their significant role in hedging and risk management, while the significant use of FRAs in Europe indicates a strong market for short-term interest rate hedging and speculation.

Figure 1: Interest rate contracts by currency (notional amount), 2023



USD = US dollar; EUR = euro; JPY = yen; GBP = sterling; CHF = Swiss franc; CAD = Canadian dollar; SEK = Swedish krona

Source: BIS data

> These shifts underscore the evolving nature of the IRD market in response to both regulatory changes and macroeconomic pressures.

Equity derivatives (EQDs)

Used for hedging or speculating on price movements, EQDs derive their value from the price movements of underlying equities, including stocks or equity indices. Key products include futures, options and swaps, but the range of variants is vast. Technical requirements include:

- Data integration.
- Market data.
- Asset price data.
- Volatility surface.

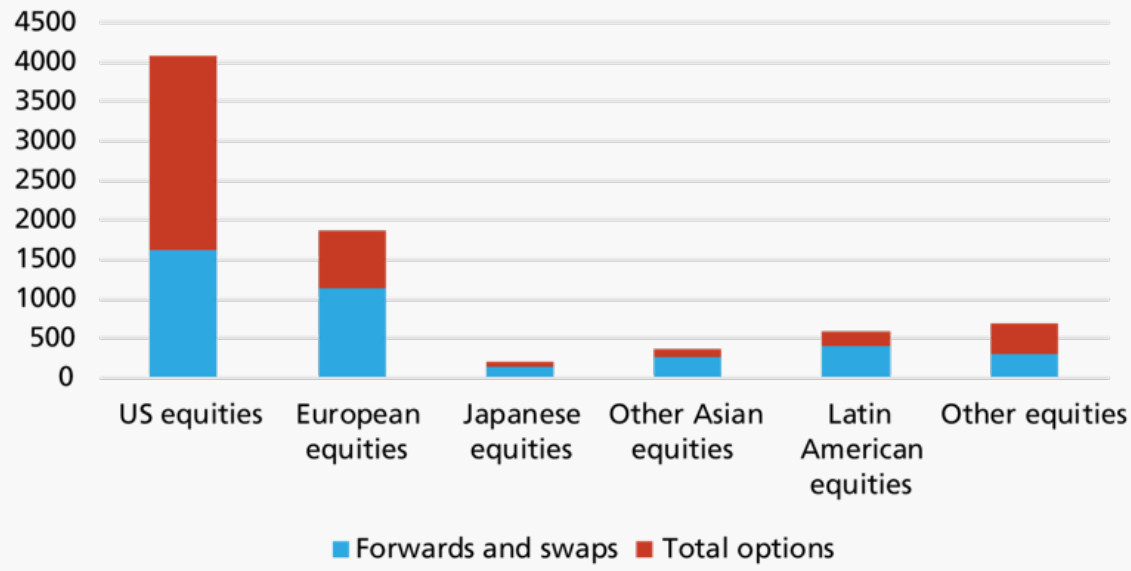
Market trends

EQDs are tools used by listed companies for both managing risk and raising capital, and the EQD market is primarily exchange-based. The OTC EQD market constitutes approximately 1.1% of the broader OTC derivatives market, and from 2008 to 2022, the size of the OTC EQD market has been relatively stable, **fluctuating between $6.3 trillion and $7.6 trillion**.

Over time, there has been a notable geographical shift in trading activity. Initially, developed countries in Europe dominated the market, accounting for 60% of overall EQD market share in 2008, with the US holding 24%. By 2022, this trend had reversed, with the US capturing 51% of market share and the share of European developed countries **decreasing to 27%**.

> ### Global market context
>
> Figure 2 illustrates the market dominance of US equities, especially US equity options. The graph also highlights the relatively high forward and swap activity in European markets, which generally have a greater reliance on bank-driven activities. While forwards and swaps may be more popular in European markets due to their ability to support bespoke exposure management, standardized option products are more popular in the more retail-driven US market.

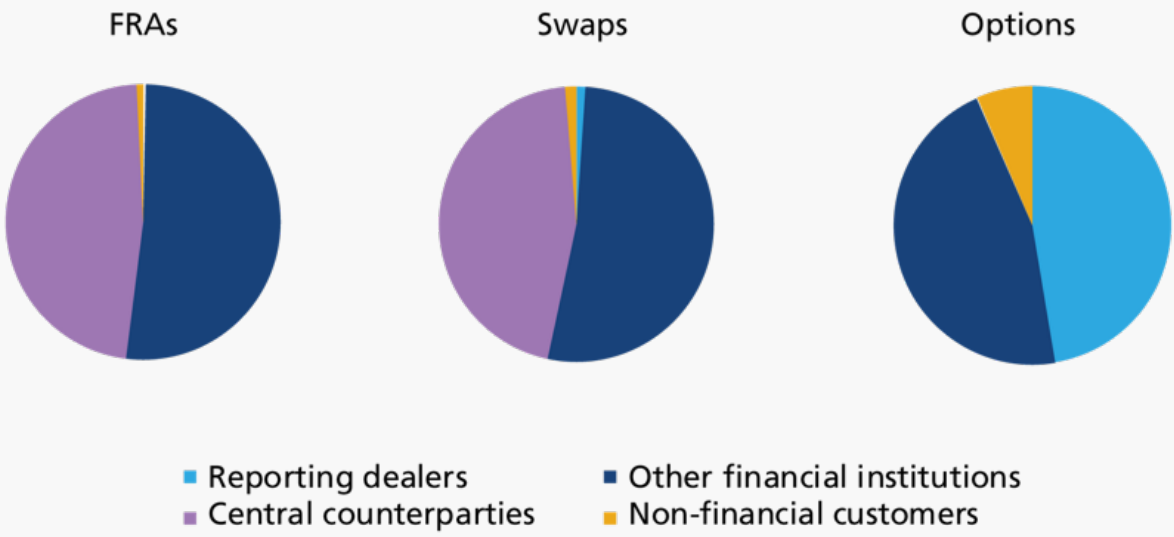
Figure 2: Equity derivatives – regional notional amount outstanding, 2023



Source: BIS data

Figure 3 illustrates the move toward central clearing for FRAs and swaps, highlighted by the significant proportion of trades involving central counterparties. The large proportion of reporting dealers highlights the practice of reporting dealers using options to intermediate customer demands and manage exposures. Options are also the only trades for which there is a relatively significant level of non-financial customers. This may suggest that corporations and governments rely on options for specific hedging requirements, rather than engaging in the broader market.

Figure 3: Distribution of notional amounts by customer type, 2023



Source: BIS data

The push from OTC to cleared markets is driven largely by stringent margin requirements and evolving regulatory frameworks, such as the Dodd-Frank Act in the US and the European Market Infrastructure Regulation (EMIR) in Europe, both of which advocate for central clearing to enhance market stability. As a result, exchanges are innovating to **offer more appealing alternatives to OTC products** that enable capital relief. The push for clearing remains indirect, influenced primarily by counterparty credit calculation rules and bilateral margin requirements. This shift is highlighted by the increasing liquidity moving from OTC to cleared markets.

However, the OTC market continues to be a vital mechanism for various institutions to implement diverse investment and hedging strategies. Equity swaps, a prominent OTC EQD product in terms of notional outstanding amounts, illustrate this trend. These instruments allow a wide array of market participants to manage positions efficiently via (for example) netting. Because of the bespoke nature of many equity swaps, they often need to remain non-cleared, despite the growing number of clearing options for sufficiently liquid OTC products.

While the OTC equity derivatives market has maintained a stable presence, the dynamics of geographical market share and the shift toward cleared

markets highlight the evolving landscape of equity derivatives trading. Rising interest rates are having a knock-on effect on the popularity of hybrid securities such as convertible bonds, as issuers seek lower coupon rates and investors look for equity growth in high-impact areas like the AI industry.

Structured products are driving growth in this market, and the significance of hedging with highly complex proprietary equity derivatives is now waning. European-style products are now also broadly available through the annuities market.

Foreign exchange (FX)

The term 'FX' refers to the trading of currencies and related instruments, and involves the buying, selling and exchange of different currencies at agreed-upon rates by a wide range of financial and non-financial customers. Products include spots, foreign exchange swaps, outright forwards and options transactions.

As for technical requirements, models are focused on volatility, so low latency is an important factor. Compared with GPUs, custom parallelization with field-programmable gate arrays (FPGAs) is better for low latency.

Market trends

The structure of the FX market is evolving amid significant volatility. This increasingly fragmented electronic marketplace consists of financial players and transactions driven by international trade. As the largest financial market, with a **staggering daily turnover** of $7.5 trillion in April 2022, it operates under relatively less domestic regulation compared with other financial instruments. The foreign exchange market is a huge, highly liquid market – the daily volume of OTC FX instruments was **$918.4 billion in April 2023** in North America alone. Despite its immense size, FX trading remains heavily concentrated in major currencies – US dollars, euros, yen and sterling – with the US dollar featuring on one side of approximately 90% of all transactions globally.

Historically, bank-dealers were the primary providers of liquidity in the FX market. With the advent and expansion of prime brokerage services, however, other players (such as high-frequency traders) have gained substantial market share. In recent times, increased volatility has prompted a shift back toward inter-dealer trading, as asset managers and high-

frequency traders adopt more cautious international strategies. This same volatility is also influencing the level of trading between dealers as they pursue risk management and hedging strategies. Increased short-maturity FX derivatives trading may reflect market uncertainty as players seek alternatives to longer-term strategies. Despite the evolving landscape and the influence of market intermediaries, liquidity provision in the FX market remains relatively concentrated among key players.

Although major currencies continue to dominate, emerging market currencies are playing an increasingly significant role in FX markets, albeit with heightened settlement risks. Despite the growing similarities between emerging market currencies and major currencies – illustrated by increased liquidity levels and international trading – geopolitical risks, such as trade wars, can disrupt liquidity. The yen (a major currency) in particular has been struggling amid market volatility, high domestic inflation and interest rate disparity. Some market participants **have suggested** that the Japanese government has intervened, buying back its own currency to prop up its position in markets.

Thinner liquidity levels in emerging market currencies also complicate price discovery, which often necessitates specialized methodologies. As time progresses, the process of determining market prices could face additional influences that stem from a broad transition away from multilateral trading platforms – sources of publicly available pricing data – toward bilateral trading arrangements that maintain transaction details confidentially. This trend towards bilateral trades is reducing the overall transparency of FX markets.

Futures and options

These focus mostly on equities, but also fixed income. Technical requirements include: big datasets that can be sliced and diced for business intelligence; often GPU-driven.

Market trends

The US market for futures and options is large, although the rest of the global market is likely to follow a similar trajectory. The US has a long-established history of active options exchanges, such as the Chicago Board Options Exchange (Cboe), which has fostered a culture of trading in standardized options. This has made options a more accessible and popular tool for both retail and institutional investors.

Securitization

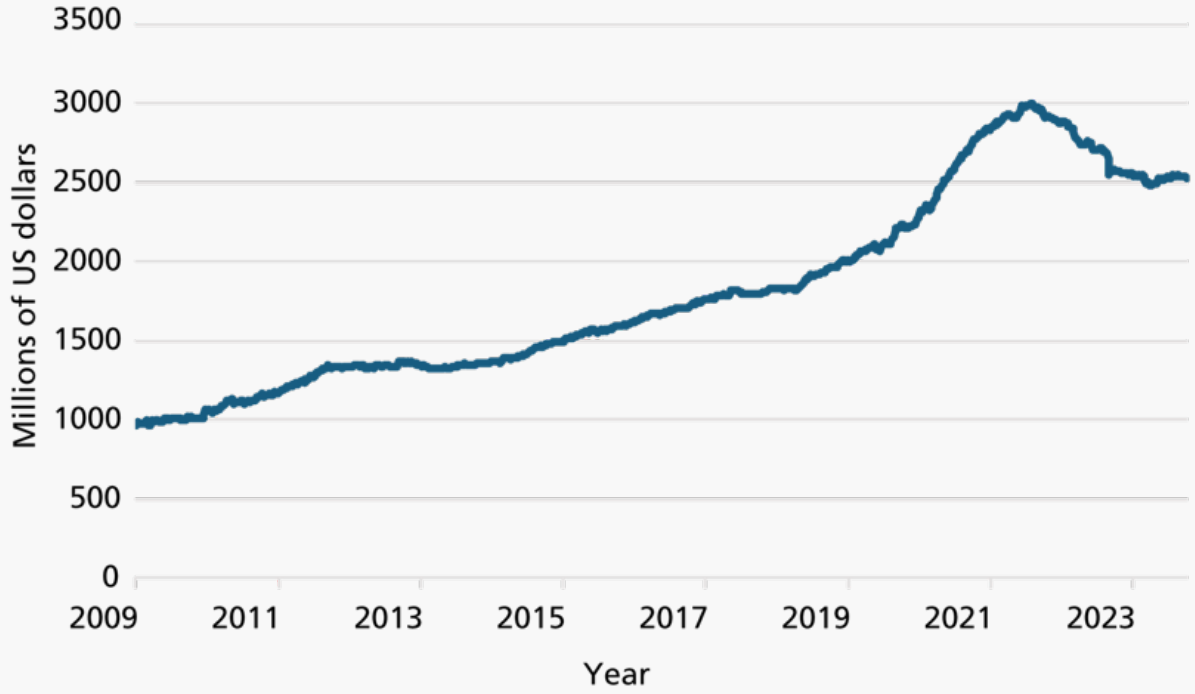
Securitization is the process of pooling illiquid contractual debt, such as residential mortgages, commercial mortgages, auto loans or credit card debt obligations, and packaging them into tradable securities. These securities, including asset-backed securities (ABS) and mortgage-backed securities (MBS), are then sold to investors, enabling lenders to generate alternative funding sources. The tranche structure of securitized products allows investors to purchase securities based on their risk profile. Products include ABS, MBS, RMBS and collateralized loan obligations (CLOs). Technical requirements include a focus on credit and portfolio dynamics, and interest rate simulation.

Market trends

Despite the securitization market's role in the 2008 financial crisis, it continues to contribute significantly to the US economy, albeit covered by substantial regulatory reforms.

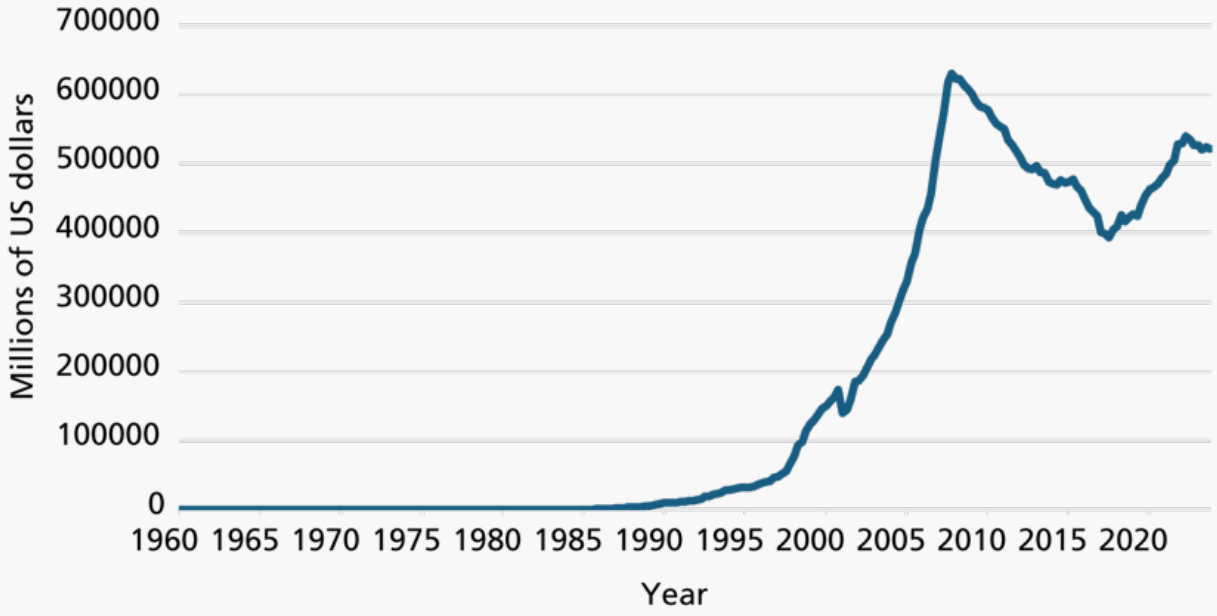
> ### Global market context
>
> Figure 4 illustrates the continued growth in mortgage-backed securities and treasury and agency-backed securities following the most recent financial crisis (between 2010 and 2020). This growth may reflect the impact of a prolonged low-interest-rate environment combined with the Fed's quantitative easing (QE) program. In 2020, the rise in holdings may reflect the Fed's pandemic-era monetary interventions. The dip in levels around 2022 highlights the impact of interest rate hikes on mortgage rate increases and the knock-on effect of prepayment rates dropping rapidly.

Figure 4: Mortgage-backed/treasury and agency securities, all commercial banks



Source: Chartis Research/Board of Governors of the Federal Reserve System (US)

Figure 5: Commercial mortgages, including securitized mortgages

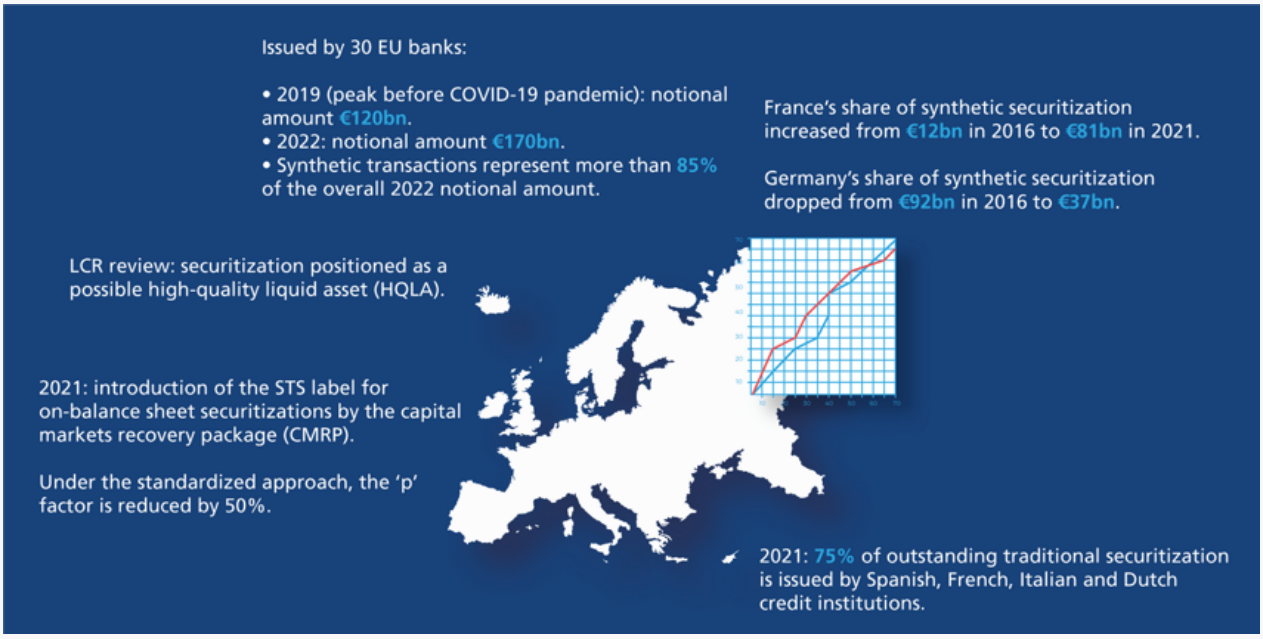


Source: Chartis Research/Board of Governors of the Federal Reserve System (US)

In contrast, the European securitization market operates at a

substantially lower level, a fact that some industry commentators attribute to the lingering effects of the financial crisis (see Figure 6).

Figure 6: Trends in the European securitization market



Source: Chartis Research/ESMA

Securitization enables banks to generate funding sources while managing their balance sheets and transferring credit risk. However, under the Basel Capital Requirements Regulation (CRR), securitizations are subject to specific capital rules because of their unique agency and model risks.

The impact of the European regulatory environment in terms of stifling the securitization market's development remains a topic of ongoing debate. Contrary to the views of some market participants and industry associations, the European Banking Authority (EBA) Joint Committee (2022) concluded that the prudential framework for securitization was not the primary obstacle to market growth. The committee highlighted low demand from both investors and originators as a significant factor. It also noted that the backing of US state agencies played a crucial role in the mortgage securitization market, with **agency-backed MBS comprising 75%** of the US securitization market in 2020.

The EU Capital Markets Union has identified the revival of the securitization market as a key priority for providing additional financing to the economy. A notable regulatory reform in 2021, introduced under the EU Capital Markets Recovery Package, extended the Simple,

Transparent and Standardised (STS) framework to synthetic on-balance sheet securitizations. This reform is particularly beneficial for banks using the standardized approach, as it reduces the 'p' factor[2] used in risk-weight calculations by 50%. It also lowers the risk-weight floor for retained senior tranches from 15% to 10%.

Policymakers in both the UK and the EU are currently reviewing the regulation of securitizations, focusing on debates around the 'p' factor and the potential impact of the Basel standardized approach (SA) output floor regime. These discussions are critical for determining future growth and stability in the European securitization market.

Market volatility and uncertainty are creating significant challenges for MBS modeling. Accurate MBS prepayment modeling depends heavily on robust historical data. Without data that reflects current market conditions, however, including scenarios where MBS are trading at a discount, firms may find it difficult to price these securities accurately.

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Vendor landscape

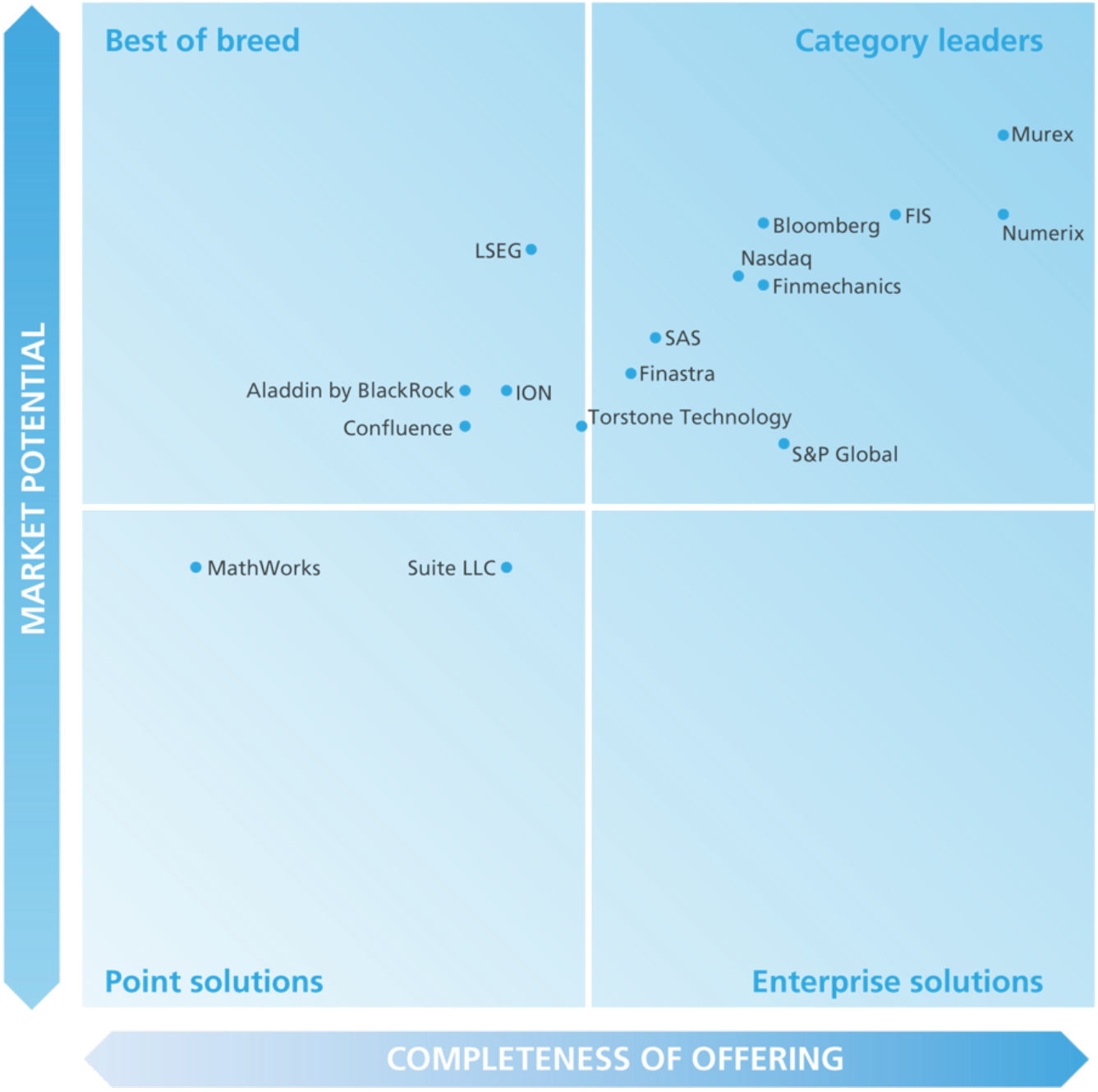
Chartis RiskTech Quadrants® and vendor capabilities for pricing and valuation systems, 2024

Figures 7 to 12 illustrate Chartis' view of the vendor landscapes for pricing and valuation systems for:

- Integrated pricing and risk management.
- Interest rate derivatives.
- Equity derivatives.
- Foreign exchange.
- Futures and options.
- Securitization.

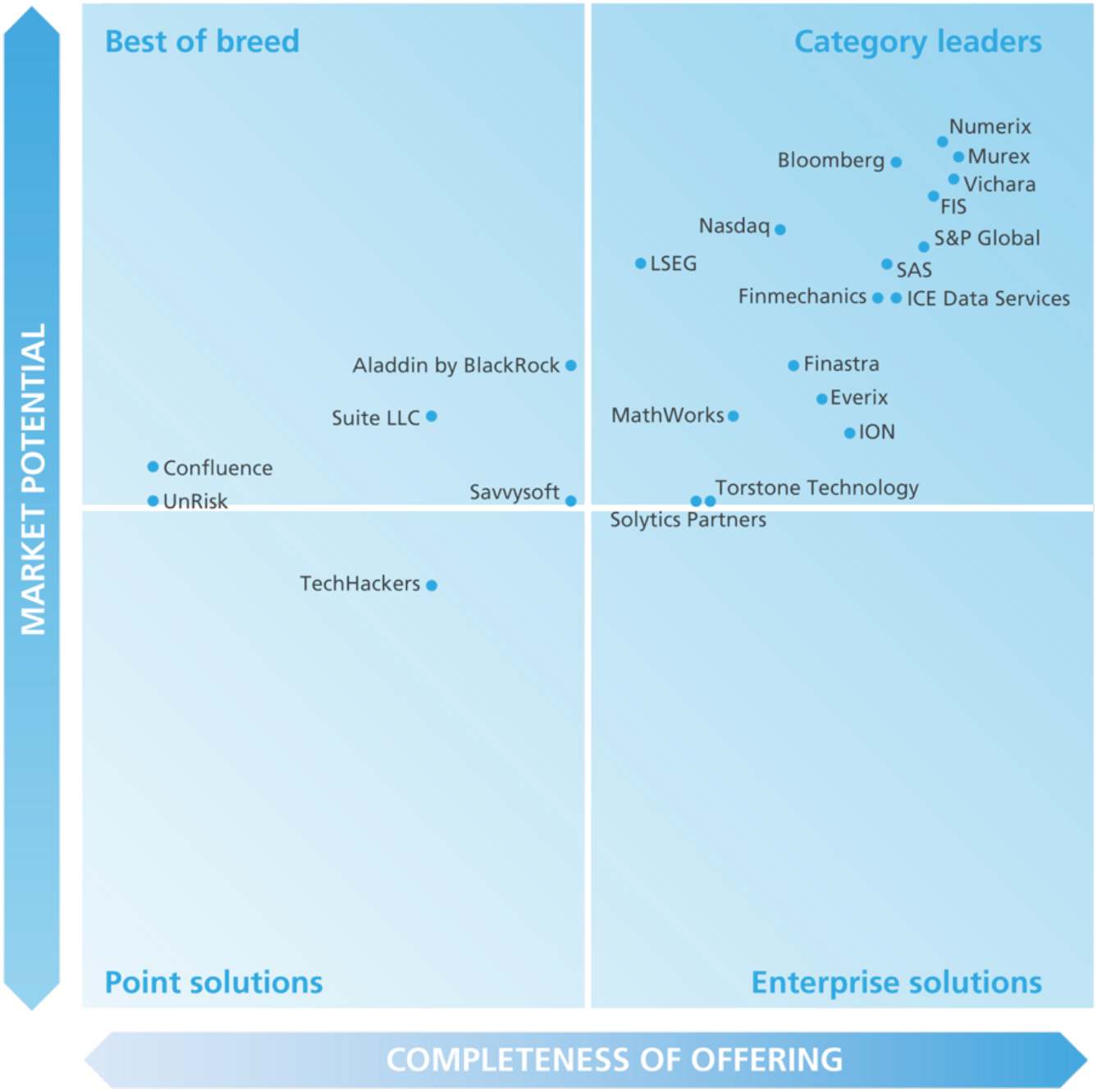
Table 1 lists the completeness of offering and market potential criteria we used to assess the vendors. Tables 2 to 7 list the respective vendor capabilities in the areas we covered.

Figure 7: RiskTech Quadrant® for pricing and valuation systems, 2024 – integrated pricing and risk management



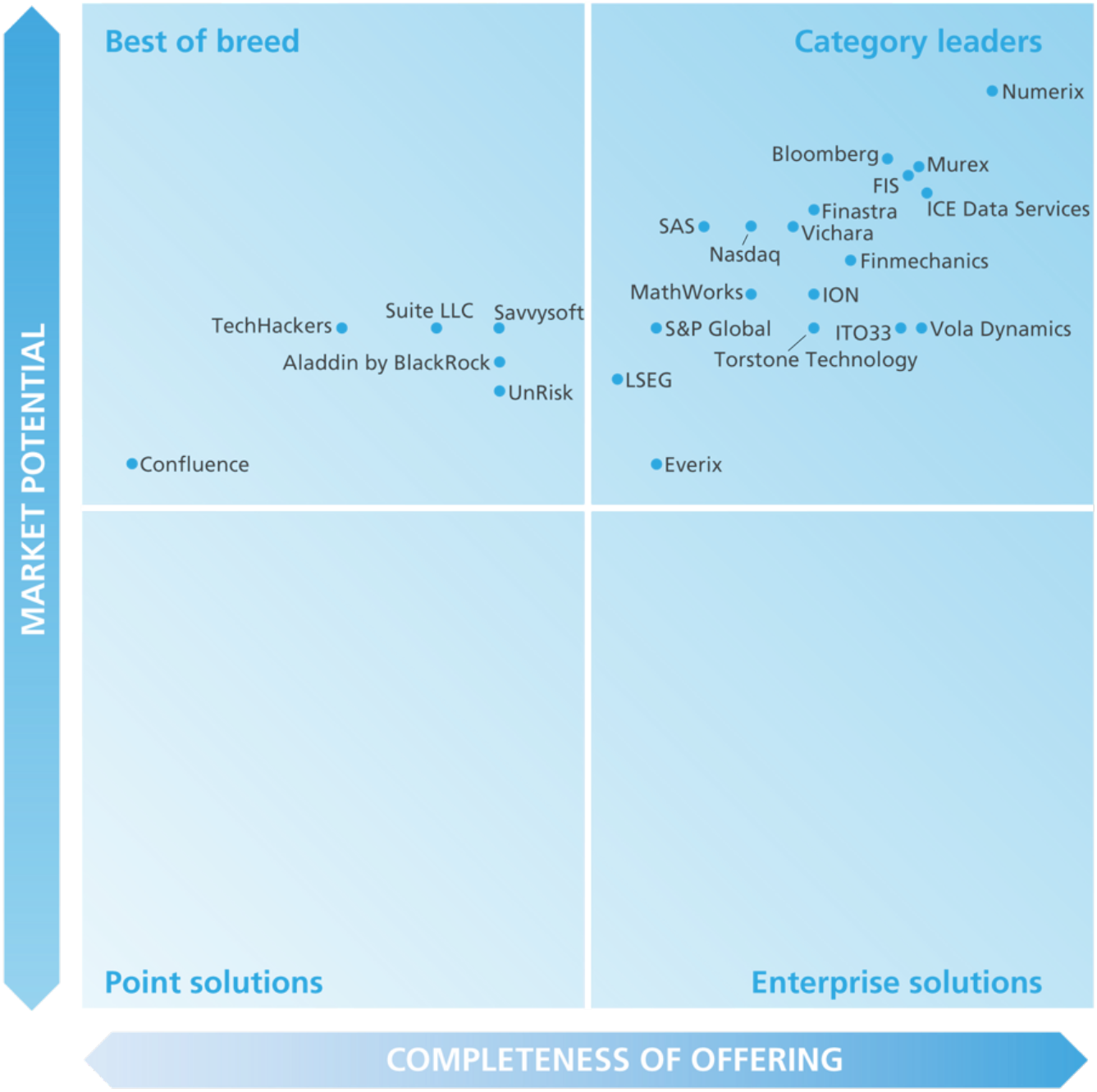
Source: Chartis Research

Figure 8: RiskTech Quadrant® for pricing and valuation systems, 2024 – interest rate derivatives



Source: Chartis Research

Figure 9: RiskTech Quadrant® for pricing and valuation systems, 2024 – equity derivatives

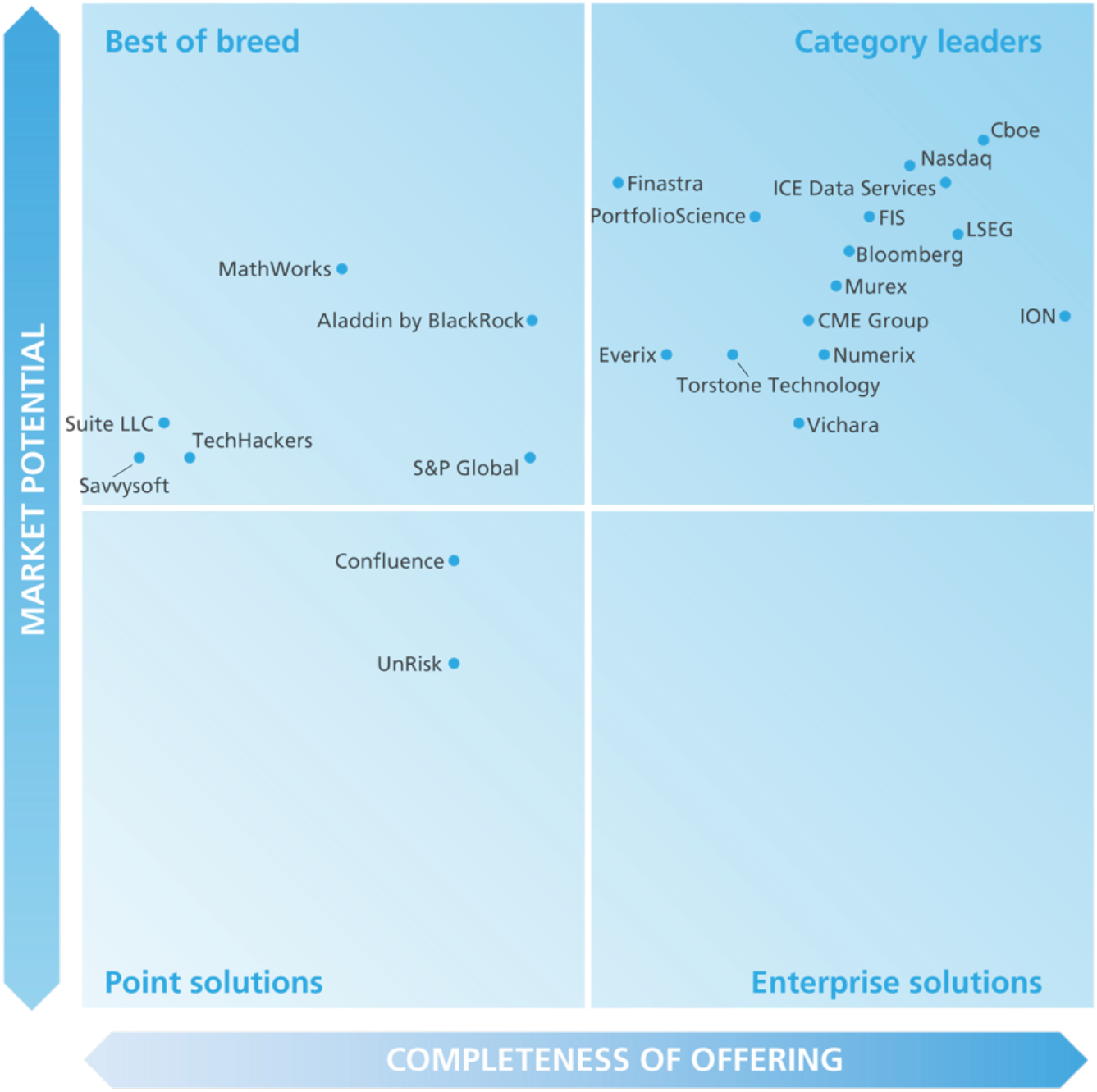


Source: Chartis Research

Figure 10: RiskTech Quadrant® for pricing and valuation systems, 2024 – foreign exchange

Source: Chartis Research

Figure 11: RiskTech Quadrant® for pricing and valuation systems, 2024 – futures and options



Source: Chartis Research

Figure 12: RiskTech Quadrant® for pricing and valuation systems, 2024 – securitization

Source: Chartis Research

Table 1: Assessment criteria for vendors of pricing and valuation systems, 2024

Completeness of offering	Market potential
Breadth of coverage	Customer satisfaction
Depth of coverage	Market penetration
P&L	Growth strategy
Hedging analytics	Business model
Library architecture (scalability, etc.)	Financials
Data interfaces	

Source: Chartis Research

Table 2: Vendor capabilities for pricing and valuation systems, 2024 – integrated pricing and risk management

Vendor	Breadth of coverage	Depth of coverage	P&L	Hedging analytics	Library architecture (scalability, etc.)	Data interfaces
Aladdin by BlackRock	***	***	***	***	***	***
Bloomberg	****	****	***	***	***	****
Confluence	***	***	***	***	***	***
Finastra	***	***	***	***	***	***
Finmechanics	****	***	****	***	****	***
FIS	****	****	****	****	****	****
ION	***	***	***	***	***	***
LSEG	****	***	***	***	***	***
MathWorks	****	***	**	**	***	**
Murex	****	***	*****	*****	*****	*****
Nasdaq	***	***	****	***	***	***
Numerix	*****	*****	****	****	****	****
S&P Global	***	***	****	****	****	****
SAS	***	***	***	****	****	***
Suite LLC	***	***	***	***	***	***
Torstone Technology	***	***	***	***	***	***

Key: ***** = Best-in-class capabilities; **** = Industry-leading capabilities; *** = Advanced capabilities; ** = Meets industry requirements; * = Partial coverage/component capability

Source: Chartis Research

Table 3: Vendor capabilities for pricing and valuation systems, 2024 – interest rate derivatives

Vendor	Breadth of coverage	Depth of coverage	P&L	Hedging analytics	Library architecture (scalability, etc.)	Data interfaces
Aladdin by BlackRock	**	**	**	**	**	**
Bloomberg	****	****	****	****	****	****
Confluence	**	**	**	**	**	**
Everix	***	***	***	***	***	***
Finastra	***	***	***	***	***	***
Finmechanics	****	****	****	****	****	****
FIS	****	****	****	****	****	****
ICE Data Services	****	****	****	****	****	****
ION	***	***	***	***	***	***
LSEG	***	***	***	***	***	***
MathWorks	***	***	***	***	***	**
Murex	****	****	****	****	****	****
Nasdaq	***	***	***	***	***	***
Numerix	****	****	****	****	*****	****
S&P Global	****	****	***	***	****	****
SAS	***	****	****	****	****	****
Savvysoft	**	**	**	**	**	**
Solytics Partners	***	***	***	***	***	***
Suite LLC	**	**	**	**	**	**
TechHackers	**	**	**	**	**	**
Torstone Technology	***	***	***	***	***	***
UnRisk	**	**	**	**	**	**
Vichara	****	****	****	****	****	****

Key: ***** = Best-in-class capabilities; **** = Industry-leading capabilities; *** = Advanced capabilities; ** = Meets industry requirements; * = Partial coverage/component capability

Source: Chartis Research

Table 4: Vendor capabilities for pricing and valuation systems, 2024 – equity derivatives

Vendor	Breadth of coverage	Depth of coverage	P&L	Hedging analytics	Library architecture (scalability, etc.)	Data interfaces
Aladdin by BlackRock	**	**	**	**	**	**
Bloomberg	****	****	****	****	****	****
Confluence	**	**	**	**	**	**
Everix	***	***	***	***	***	***
Finastra	***	***	***	***	***	***
Finmechanics	***	****	****	****	****	****
FIS	****	****	****	****	****	****
ICE Data Services	****	*****	****	****	****	****
ION	***	***	***	***	***	***
ITO33	****	*****	****	****	****	****
LSEG	***	***	***	***	***	**
MathWorks	***	***	***	***	***	***
Murex	****	****	****	****	*****	****
Nasdaq	***	***	***	***	***	***
Numerix	****	*****	*****	****	*****	****
S&P Global	***	***	***	***	***	***
SAS	***	***	***	***	***	***
Savvysoft	**	**	**	**	**	**
Suite LLC	**	**	**	**	**	**
TechHackers	**	**	**	**	**	**
Torstone Technology	***	***	***	***	***	***
UnRisk	**	**	**	**	**	**
Vichara	****	****	***	***	***	***
Vola Dynamics	****	*****	****	****	****	****

Key: ***** = Best-in-class capabilities; **** = Industry-leading capabilities; *** = Advanced capabilities; ** = Meets industry requirements; * = Partial coverage/component capability

Source: Chartis Research

Table 5: Vendor capabilities for pricing and valuation systems, 2024 – foreign exchange

Vendor	Breadth of coverage	Depth of coverage	P&L	Hedging analytics	Library architecture (scalability, etc.)	Data interfaces
Aladdin by BlackRock	**	**	**	**	**	**
Bloomberg	****	****	****	****	****	****
Confluence	**	**	**	**	**	**
Everix	***	***	***	***	***	***
Finastra	***	***	***	***	***	***
Finmechanics	****	***	***	***	****	***
FIS	****	****	****	****	****	****
ICE Data Services	****	****	****	****	****	****
ION	***	***	***	***	***	***
LSEG	***	***	***	***	***	***
MathWorks	***	***	***	***	***	**
Murex	****	****	****	****	****	****
Nasdaq	***	***	***	***	***	***
Numerix	****	****	****	****	*****	****
S&P Global	***	***	***	***	***	***
SAS	***	***	***	***	***	**
Savvysoft	**	**	**	**	**	**
Solytics Partners	***	***	***	***	***	***
Suite LLC	**	**	**	**	**	**
TechHackers	**	**	**	**	**	**
Torstone Technology	***	***	***	***	***	***
UnRisk	***	***	***	***	***	**
Vichara	***	***	***	***	***	***

Key: ***** = Best-in-class capabilities; **** = Industry-leading capabilities; *** = Advanced capabilities; ** = Meets industry requirements; * = Partial coverage/component capability

Source: Chartis Research

Table 6: Vendor capabilities for pricing and valuation systems, 2024 – futures and options

Vendor	Breadth of coverage	Depth of coverage	P&L	Hedging analytics	Library architecture (scalability, etc.)	Data interfaces
Aladdin by BlackRock	***	***	**	**	**	**
Bloomberg	***	***	***	****	***	***
Cboe	****	*****	****	***	****	***
CME Group	***	***	***	***	***	*****
Confluence	**	**	**	**	**	**
Everix	***	****	***	**	***	**
Finastra	***	***	***	***	***	**
FIS	*****	***	***	*****	***	***
ICE Data Services	****	***	****	****	***	****
ION	*****	*****	*****	*****	*****	*****
LSEG	****	***	****	****	****	****
MathWorks	**	**	**	**	**	*
Murex	***	***	***	****	***	***
Nasdaq	****	****	***	***	***	***
Numerix	***	***	***	***	***	***
PortfolioScience	***	***	***	***	***	***
S&P Global	***	**	***	**	**	**
Savvysoft	**	**	**	**	**	**
Suite LLC	**	**	**	**	**	**
TechHackers	**	**	**	**	**	**
Torstone Technology	***	***	***	***	***	***
UnRisk	**	**	**	**	**	**
Vichara	***	***	***	***	****	***

Key: ***** = Best-in-class capabilities; **** = Industry-leading capabilities; *** = Advanced capabilities; ** = Meets industry requirements; * = Partial coverage/component capability

Source: Chartis Research

Table 7: Vendor capabilities for pricing and valuation systems, 2024 – securitization

Vendor	Breadth of coverage	Depth of coverage	P&L	Hedging analytics	Library architecture (scalability, etc.)	Data interfaces
Aladdin by BlackRock	***	****	***	**	***	**
Andrew Davidson & Co.	***	****	**	**	***	**
Bloomberg	*****	****	***	***	***	***
Confluence	**	**	****	***	**	**
Finastra	**	**	**	****	***	**
FIS	****	****	***	***	***	****
ICE Data Services	***	***	****	****	***	****
Intex	***	*****	**	**	**	****
ION	***	***	***	***	***	***
LSEG	***	*****	***	****	***	***
MathWorks	**	**	**	**	**	**
MIAC Analytics	***	***	****	***	***	**
Moody's	****	****	****	****	***	****
MSCI	****	***	****	***	***	***
Murex	***	***	***	***	***	**
Nasdaq	***	***	***	***	***	***
Numerix	****	*****	****	****	****	***
RiskSpan	****	****	****	***	***	*****
S&P Global	****	****	***	***	***	****
SAS	***	***	***	***	***	***
Savvysoft	**	**	**	**	**	**
Suite LLC	**	**	**	**	**	**
TechHackers	**	**	***	**	**	**
Thetica Systems	***	***	***	***	***	*****
Torstone Technology	**	**	**	**	**	**
Trepp	***	**	**	**	**	**
UnRisk	**	**	**	**	**	**
Vichara	*****	****	****	****	****	*****

Key: ***** = Best-in-class capabilities; **** = Industry-leading capabilities; *** = Advanced capabilities; ** = Meets industry requirements; * = Partial coverage/component capability

Source: Chartis Research

Notes

1. Note that references to companies in the text of this report do not constitute endorsements of their products or services by Chartis.

2. The ‘p’ factor is a calculation used to determine the valuation uncertainty adjustment or discount applied to the reported fair value of financial instruments.

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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 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.

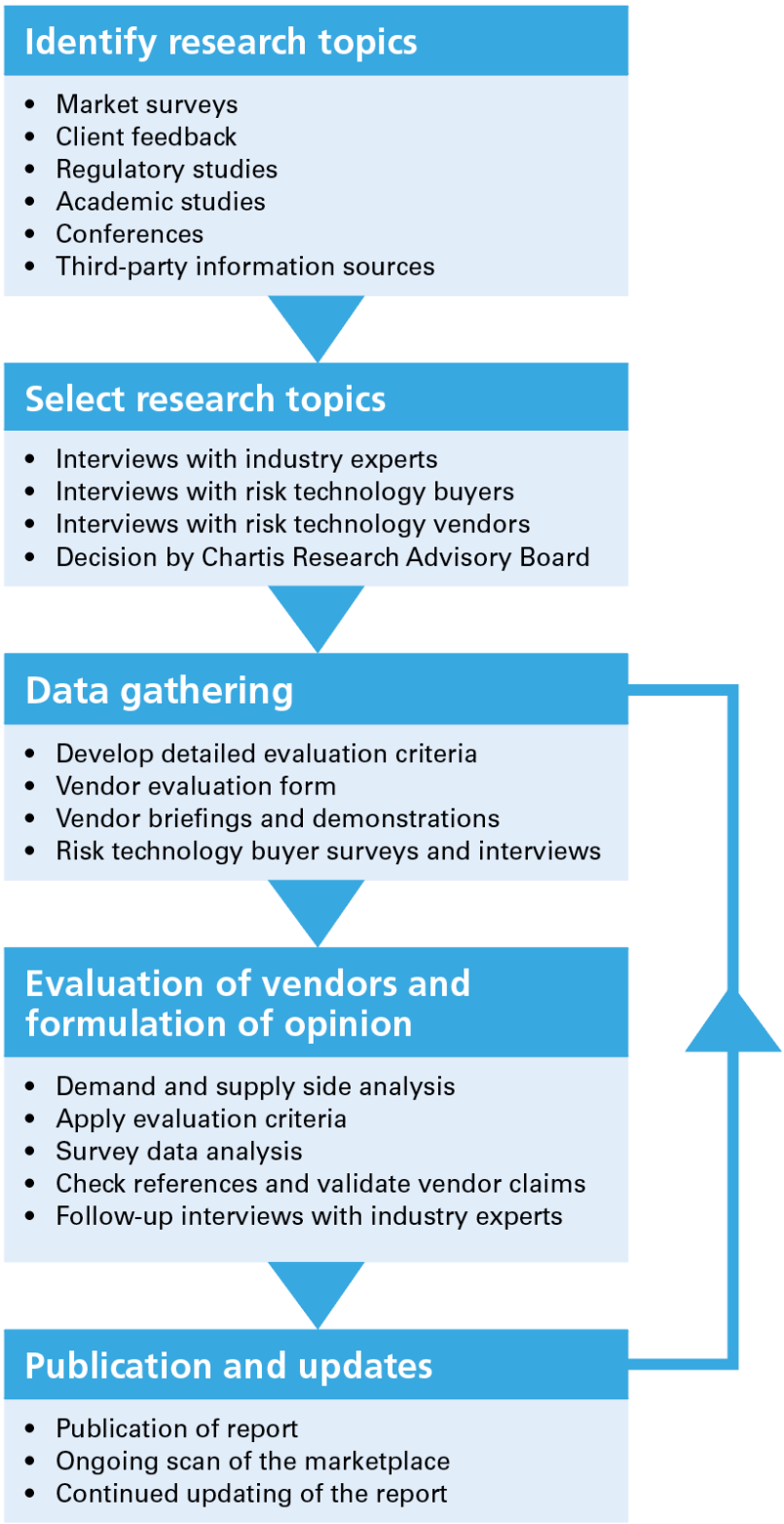
Inclusion in the RiskTech Quadrant®

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 13 below describes the research process.

Figure 13: 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):

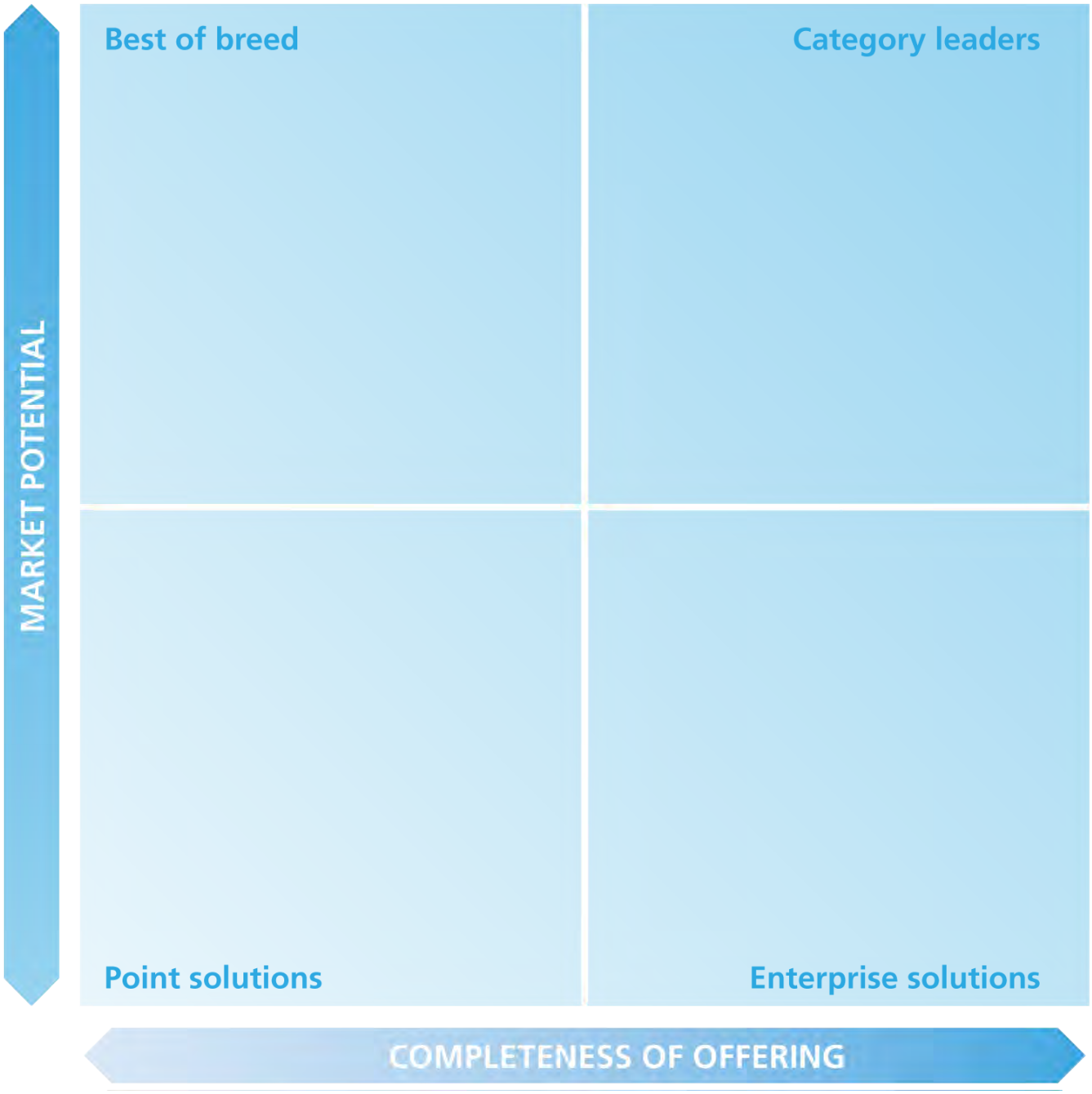
- **Chartis vendor evaluation forms.** A detailed set of questions covering functional and non-functional aspects of vendor solutions, as well as organizational and market factors. Chartis' vendor evaluation forms are based on practitioner-level expertise and input from real-life risk technology projects, 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 14) evaluates vendors on two key dimensions:

1. Completeness of offering
2. Market potential

Figure 14: 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 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 varies for each subject area, but special attention is 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.

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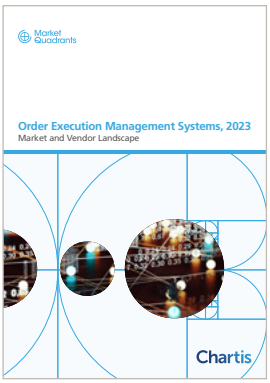
Further reading



Order Execution Management Systems, 2023: Market and Vendor Landscape

Algorithmic Trading Solutions, 2022: Market and Vendor Landscape

Portfolio Management Platforms, 2021: Market and Vendor Landscape

RiskTech Buyside50 2022

STORM 2024

RiskTech100 2024

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