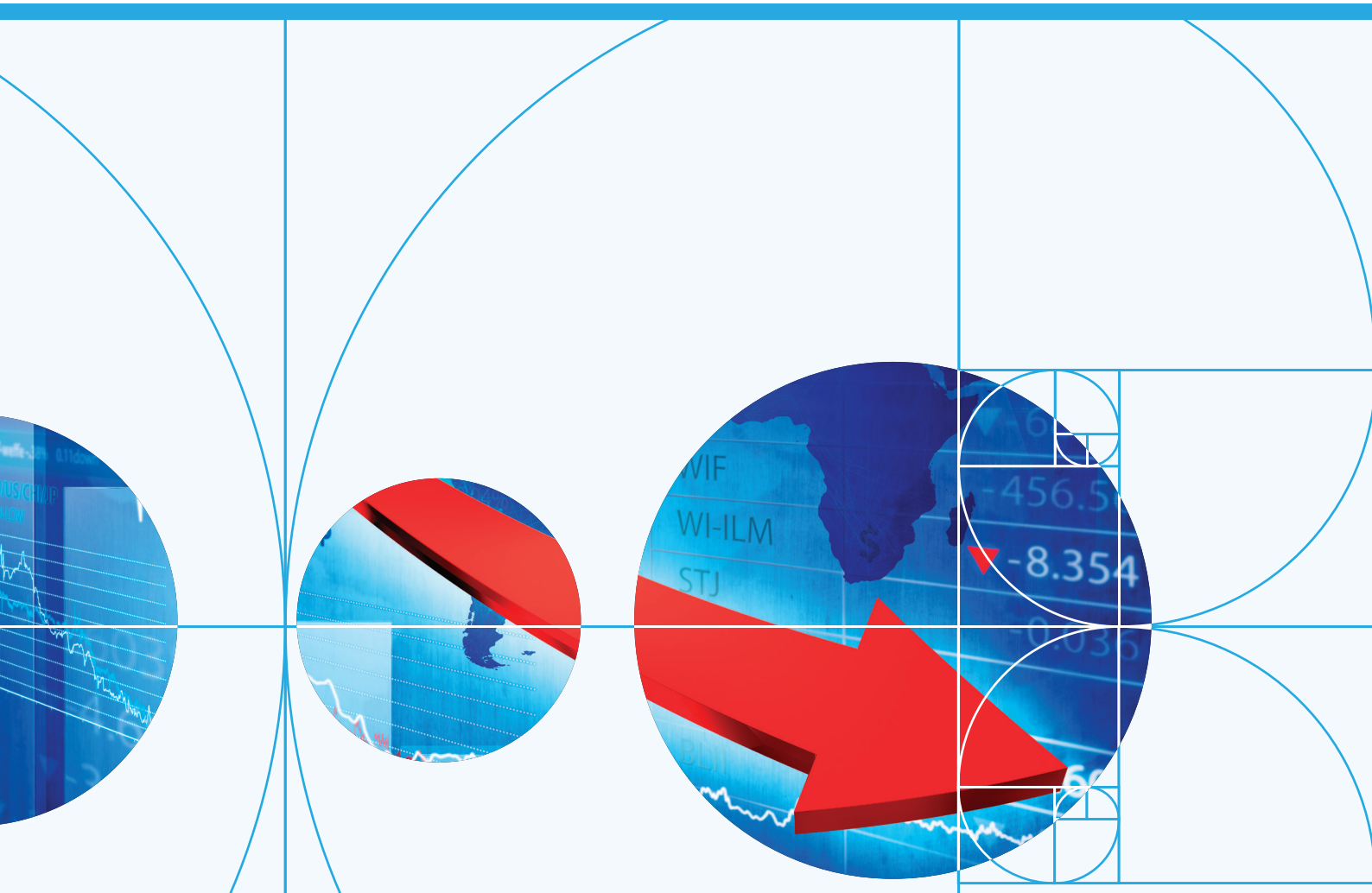
Market Quadrants

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

## Market Update and CVA/CLO Solutions Vendor Landscape

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

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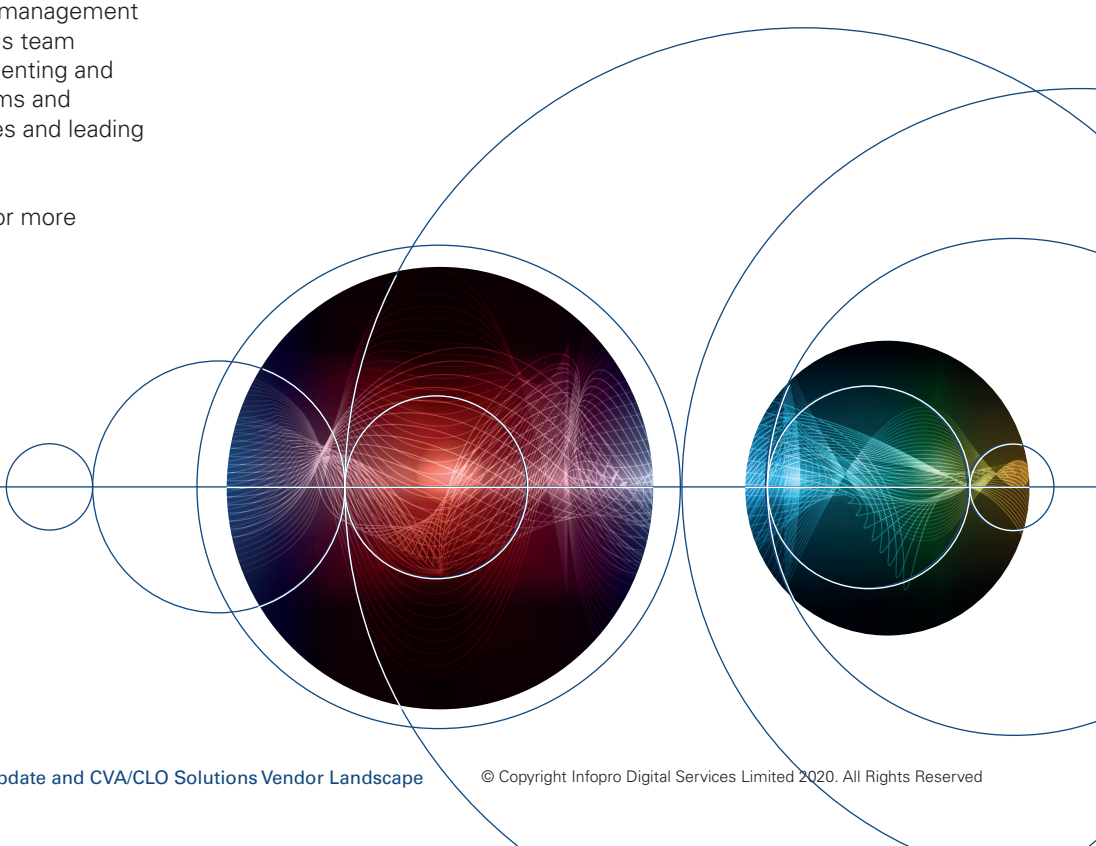

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# 1. Executive summary

**This report builds on the themes discussed in *Technology Solutions for Credit Risk 2.0, 2018*, published in May 2018. In that report we identified an emerging credit risk environment – which we call Credit Risk 2.0 – in which the banking book and default risk analytics are experiencing a structural revolution. Every aspect of the banking book, from data to core analytics, is in the process of being reshaped by the impact of technology and accounting standards.**

In 2019[1] we considered the structural changes these 'risk-aware accounting' standards – such as International Financial Reporting Standard (IFRS) 9 and Current Expected Credit Losses (CECL) – have made to the vendor landscape, and assessed the new tools and capabilities that financial institutions (FIs) need to comply effectively.

In this report we analyze four key segments of the credit landscape:

- Credit for the banking book.
- Credit for the trading book (xVA/credit valuation adjustment [CVA]/margin analytics).
- Traded credit markets (credit-risk fixed-income products including corporate credit, collateralized debt obligations [CDOs], collateralized loan obligations [CLOs] and high-yield credit).
- Credit for wealth management.

Highlighting the key trends across all segments of the credit landscape, we focus on analytics, considering the rapidly moving credit revolution, its regulatory drivers, and the evolving technology consequences arising from it. We also examine the relative rates of adoption for new and different technological paradigms in the four key segments of the credit risk landscape listed above.

Finally, to complement our previous analysis of credit in the banking book, the report includes a more detailed exploration of the extensive and diverse trading book segment of the credit landscape. It includes deep dives into the rapidly growing CLO and CVA markets, assesses developments in dedicated specialist analytics, and provides a view of the vendor landscape in each segment. Because CLO and CVA software solutions are highly differentiated, the vendor capabilities tables in this report will highlight the methodological differences between both approaches to modeling credit risk.

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

This report covers the following providers of CVA and CLO solutions: Bloomberg, Calypso, Finastra, FIS, Fitch Ratings, IHS Markit, Intex, Kamakura, LPC Collateral, Moody's Analytics, MSCI, Murex, Numerix, Quantifi, Quaternion, RiskSpan, SS&C, Thetica Systems, Trepp, TriOptima, VALITANA, Vichara, Wolters Kluwer.

*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 responded to our requests for briefings, and some declined to participate in our research.*

[1] *See 'Technology Solutions for Credit Risk 2.0; Vendor Landscape, 2019'.*

# 2. Market update

## Context: a revolution driving change in four key areas of credit

In our previous Credit Risk 2.0 report[2], we highlighted how the credit risk environment is changing, driven by three factors:

- **Changing regulations and reporting standards**. New 'risk-aware accounting' standards, such as IFRS 9 and CECL, are changing the fundamental nature of how default risk is calculated. In addition, Basel IV/FRTB[3], due to be implemented in 2021, will affect the way that FIs calculate risk-weighted assets (RWA) and capital floors, constraining the use of internal models.

- **Changes to counterparty risk management**. Regulators have renewed their focus on market-linked contingent credit in the trading book (with measures such as standardized approach for counterparty credit risk [SA-CCR] and FRTB-CVA). These reforms are pushing FIs to adopt clearer, more stringent and sustainable practices for measuring and managing counterparty risk. Despite the heightened focus on bilateral collateralization and the increase in trade volumes through cleared markets, CVA remains a significant dynamic in this area. We examine the various types of CVA – including regulatory, accounting and trade pricing – in more detail later in the report, examining their ongoing evolution and the key technical challenges they create for FIs.

- The recent emergence of **new computational techniques** for assessing credit and credit risk. These include changes to the underlying mathematical models, such as new graph-based approaches, for example. Graph analytics (GA) are techniques that analyze network relationships, employing graph theory and combinatorial mathematics, and simplifying their implementation using graph databases.

- Intersecting these three trends are evolving demands for *data* and *data technology*. Driven in part by the barrage of regulation and reporting requirements hitting the credit space, FIs are increasingly looking to obtain data from third parties, in larger volumes and with greater granularity than ever before. To address this, technology vendors are vying to provide the analytical tools to process this data, as well as the interfaces to manage its many sources, and the databases to store it.

## Credit analytics take center stage (1)

In this context, this report analyzes trends and developments in *credit analytics*. Credit analytics are a core element of the new credit risk environment. Every aspect of credit modeling has been transformed in recent years, and many new mathematical techniques have become widespread. Some transformations are still evolving, however, and the analytical shift has not affected each segment of the market in the same way, as we discuss in the following sections.

The most transformational change has happened in the banking book, as credit-risk processes become ever more analytically intensive.

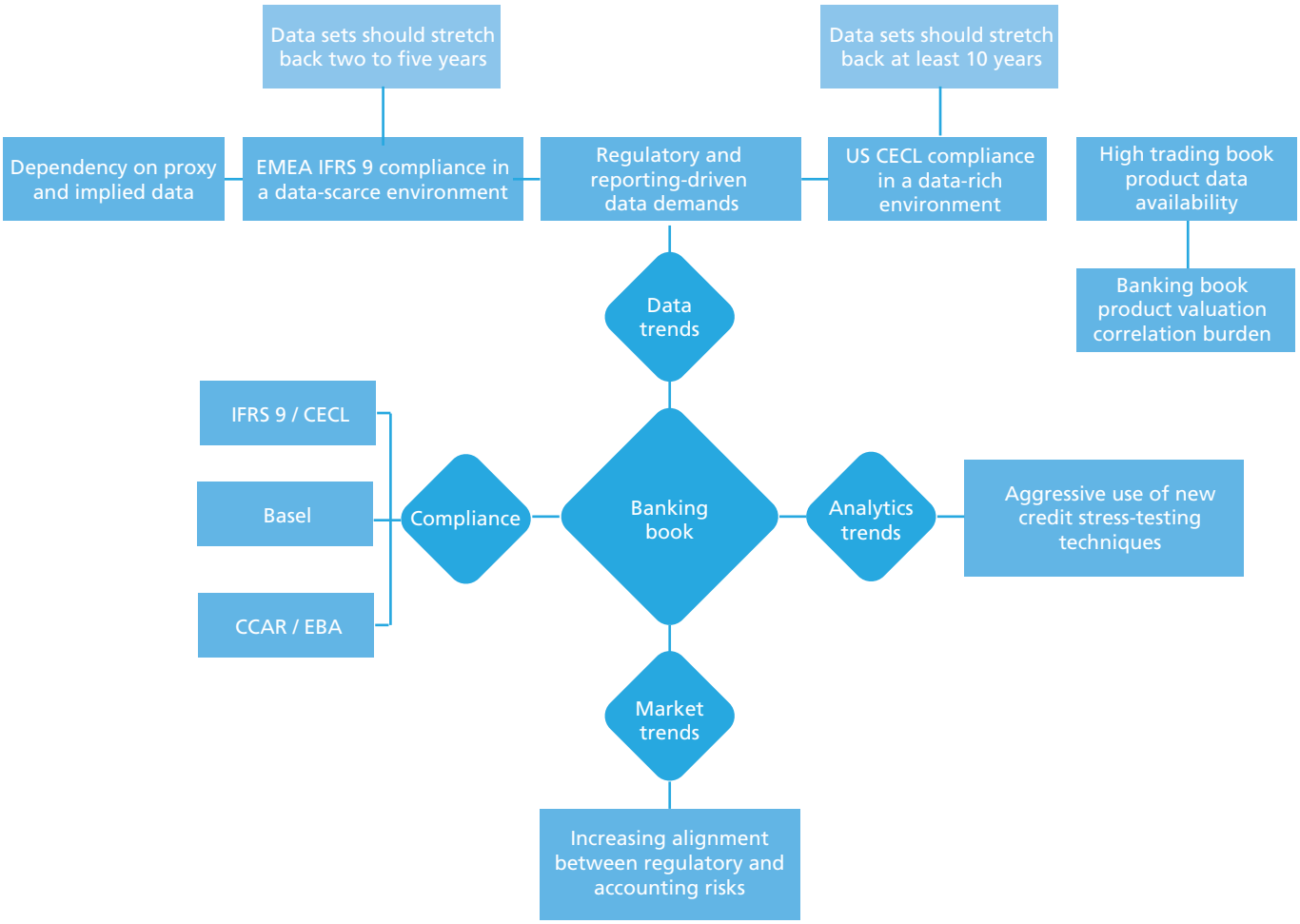
### Credit analytics in the banking book

The development of analytics in the banking book has been transformational, as IFRS 9, CECL and similar standards catalyze the implementation of forward-looking impairment modeling techniques. As a result, banks have modified many of their credit-intensive processes, particularly in the banking book (see Figure 1). This, in turn, is resulting in changes to their specific technological and methodological foundations, including the requirement to build detailed performance models for the new credit frameworks that are emerging.

The introduction of IFRS 9/CECL, as well as Basel Committee principles Interest Rate Risk in the Banking Book (IRBB), has alerted businesses, P&L owners and investors that certain instrument structures and embedded optionality have very significant impacts on cash flows and profitability. For FIs, IFRS 9 and CECL have also highlighted that the standard assumptions of market-oriented discount rates, credit default curve shapes, macroeconomic curves and structures do not align with their portfolios, potentially leading to considerable divergence in value.

[2] *'Technology Solutions for Credit Risk 2.0, 2018'.*
[3] *Fundamental Review of the Trading Book.*

**Figure 1: Key trends in the banking book**




*Source: Chartis Research*

## xVA/CVA/margin analytics

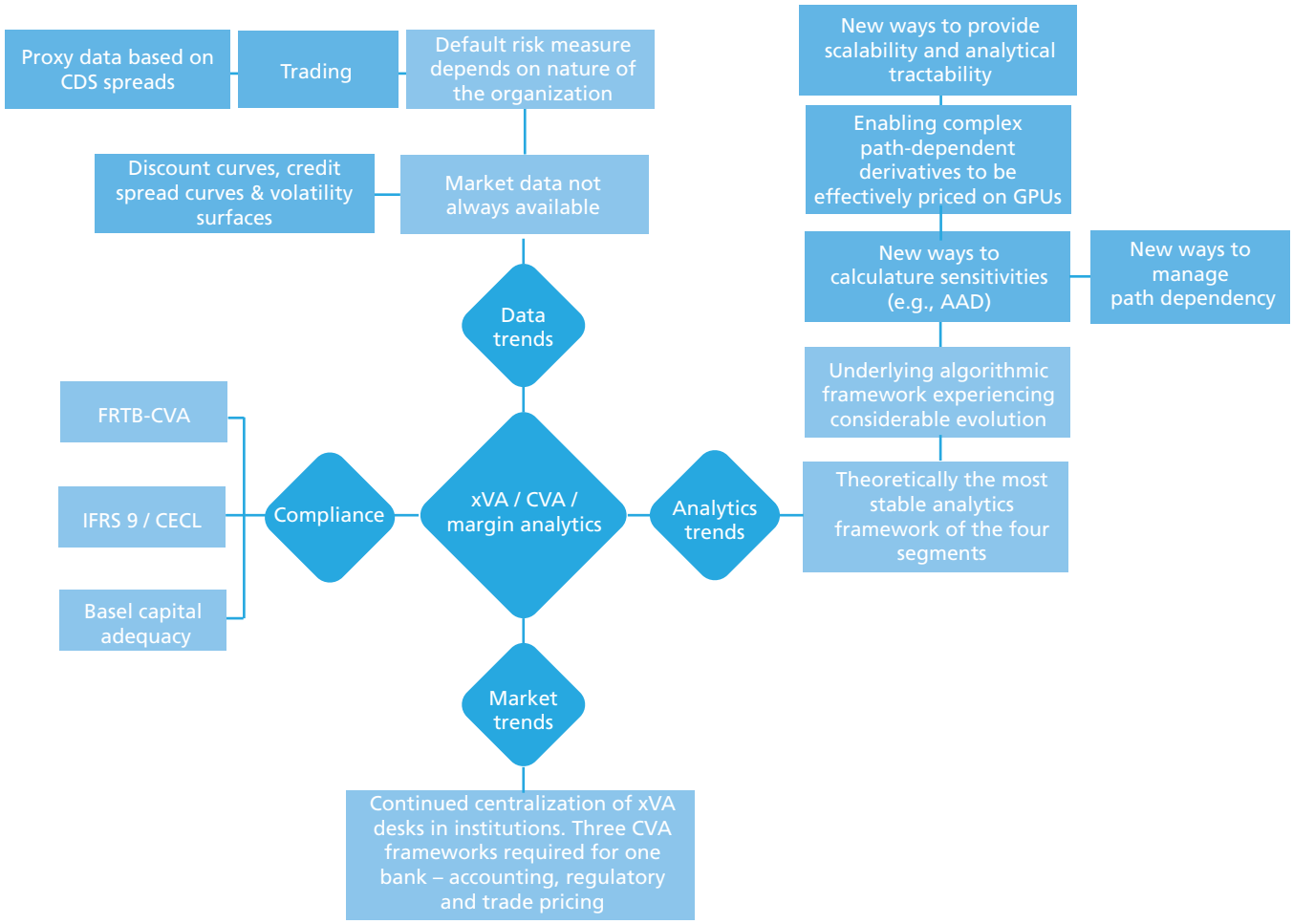
In the area of contingent credit and margin analytics (such as CVA, potential future exposure [PFE] and margin valuation adjustment [MVA]), the core analytics framework is comparatively stable (see Figure 2). Computational efficiency is a key concern for FIs when calculating contingent credit and margin adjustments. Even compared to CVA, calculating the cost of MVA and capital valuation adjustment (KVA) is computationally intensive, particularly when these processes include the computation of forward versions and their respective sensitives.

*xVA sensitivity* is the sensitivity of a particular xVA to underlying risk factors, which in turn can have many drivers, including interest rate curves, credit spreads and foreign exchange rates.

Institutions implementing the standard approach for CVA valuation (SA-CVA) will have to make CVA sensitivity calculations as part of their Basel IV/ FRTB-CVA compliance.

While at a high level the overarching theoretical developments have broadly ceased, physical implementation of the overall methods is developing rapidly (in other words, while the mathematical and calculation techniques are relatively stable, how and what algorithms are used is still being developed). As with the overarching contingent credit analytics, the structure of CVA models has changed little; those changes that are occurring are happening in the actual underlying implementation mechanics. So, for example, there has been considerable evolution in the algorithmic framework that underpins high-level theoretical models.

**Figure 2: Key trends in xVA/CVA/margin analytics**




*Source: Chartis Research*

The four central innovations in CVA calculations are:

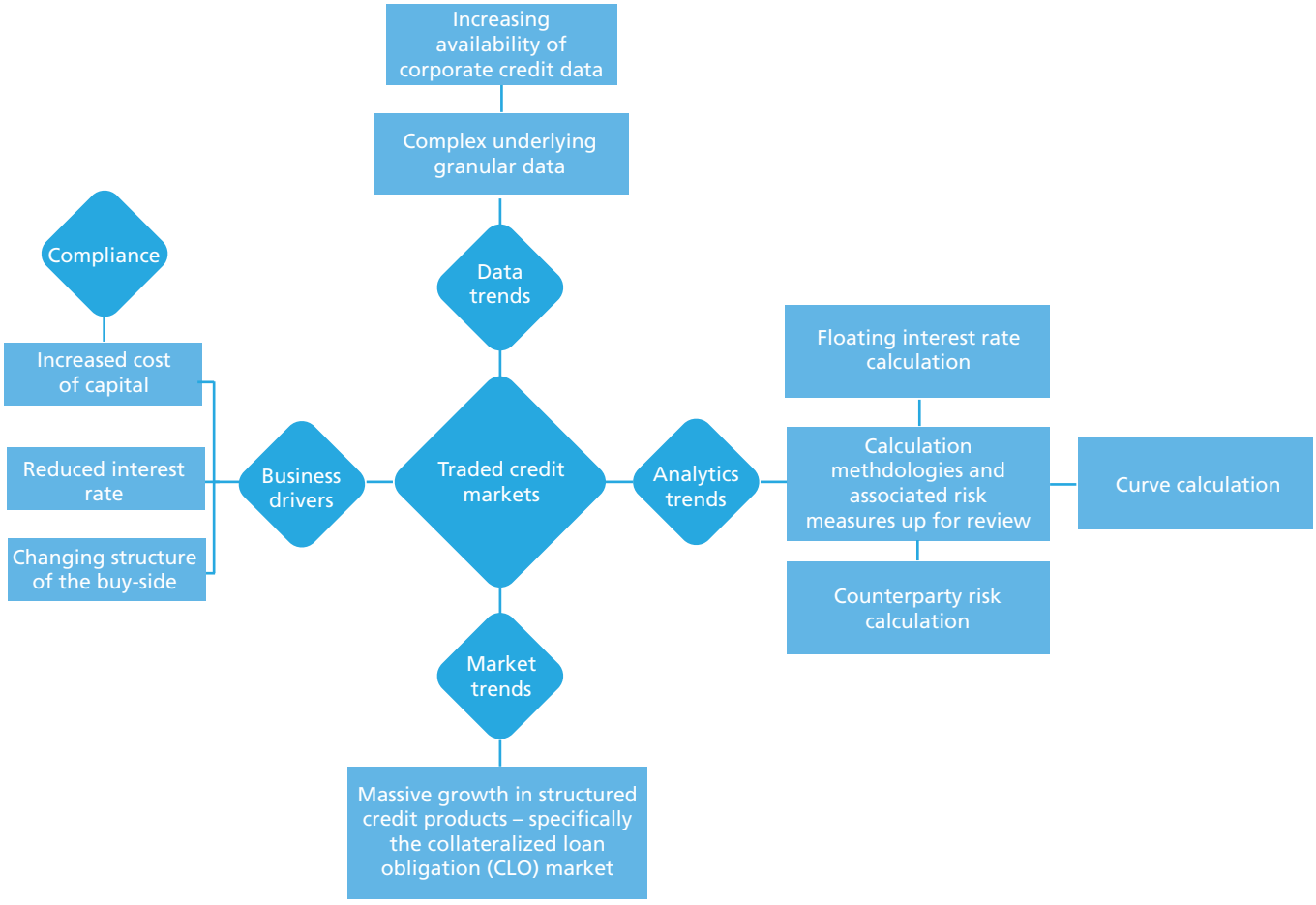
- Adjoint algorithmic differentiation (AAD) for CVA sensitivities, enhancing the efficiency of CVA P&L explain.
- The use of data parallel strategies for CVA analytics.
- An intermediate approximation engine that enables users to replicate front-office analytics more efficiently. This can reduce some of the complex trade-offs FIs must make around speed and completeness of coverage.
- Computational transformations that enable complex path-dependence derivatives CVA calculations on graphics processing units (GPUs).

The use of higher-dimensional correlation and regression models is one area in which FIs can make significant efficiency gains. Complex non-parametric simulation can be captured efficiently by machine learning (ML) tools (and in particular neural network approaches). Other areas in which analytics can aid efficiency include leveraging approximation functions (with ML and Chebyshev approximation frameworks, for example) to approximate, capture and linearize complex path dependence (in the intermediate approximation engine).

## Traded credit markets

Within the overall credit landscape, the traded credit market is burgeoning (see Figure 3). The CLO market in particular has grown significantly in the past 10 years. These complex structured products present unique challenges for analytics, including liquidity risk measures and credit attribution

**Figure 3: Key trends in traded credit markets**




*Source: Chartis Research*

calculations. Corporate credit has expanded massively, with a wide range of new venues and venue types. While no venue has proved a 'silver bullet' when it comes to solving the liquidity conundrum in traded credit markets, a broader set of options and alternatives is available.

### Wealth management and private banking

In the current low-interest rate environment, private banking and wealth management clients are progressively taking on more strategic liabilities to optimize their balance sheets (see Figure 4). This strategy comes at a cost, however: complexity – mostly for the banks. Analyzing private banking clients' credit can be a complicated task, because they straddle the boundary between large corporate and retail clients. While these clients can be individuals, or often families (like retail clients), their assets are likely to be substantially more corporate in style, in terms of what is invested and how. Carrying out a credit analysis of these often complex structures can be a challenge.

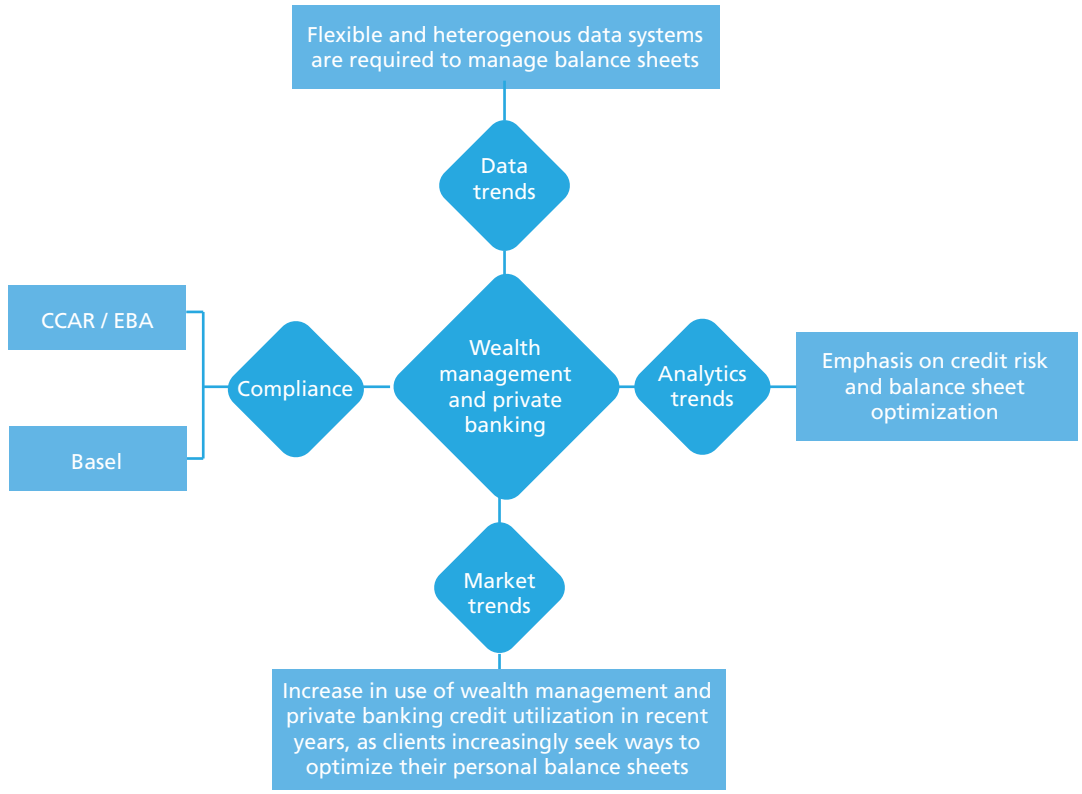
Collateral management for private banking assets also adds a layer of complexity to the process of handling banking-book collateral (because of factors such as a lack of standardization, complex structure, lack of standard documents, and unstructured valuation processes).

## Background

### The transformation of credit analytics

Following the transformation of credit modeling, many new mathematical techniques have become widespread (see Figure 5). IFRS 9, for example, has inspired a set of responses from banks, which have modified many of their credit-intensive processes (such as impairment modeling). The standard has

**Figure 4: Key trends in wealth management and private banking**




*Source: Chartis Research*

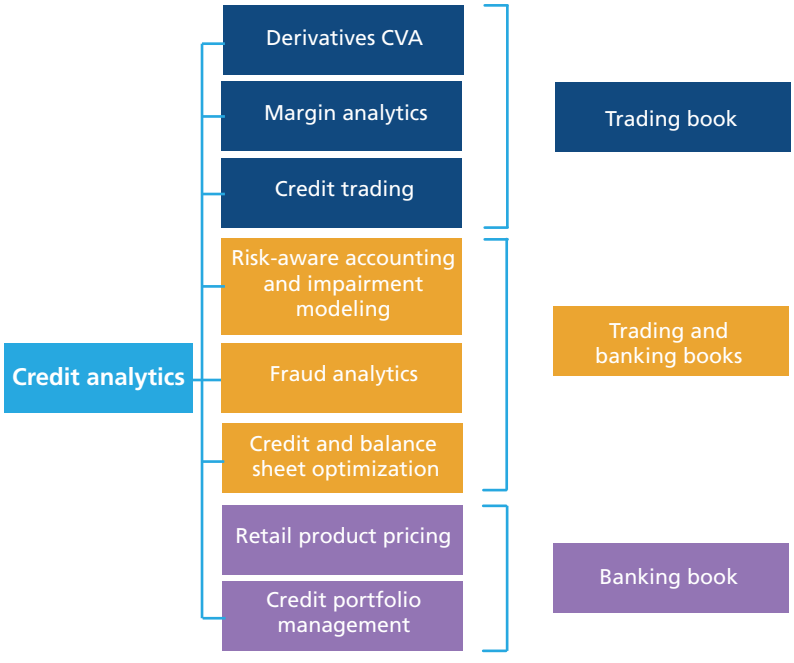
catalyzed changes to the specific technological and methodological landscape underpinning these processes. Requirements include building detailed performance models for the new credit frameworks that are emerging.

Many transformations remain in mid-flight – the theoretical and methodological underpinnings of most aspects of traded credit modeling (such as CLOs) continue to evolve. Of all market segments, margin analytics is the area that is most methodologically stable.

Different credit applications require different analytical components. In recent years credit and balance sheet optimization, for example, have become a focus in private banking and wealth management (see Table 1). And alongside existing statistical frameworks, new tools such as ML and GA are making deep inroads.

A variety of new tools are transforming the environment for credit processes and analytics. While ML-style models have had the most dramatic impact in retail banking, traditional tools and techniques (such as simulation engines and

**Figure 5: New style credit analytics are being applied across the financial landscape**




*Source: Chartis Research*

**Table 1: Suitability of different statistical techniques for credit risk analytics and processes**

| Credit analytics/credit flow process | ML | GA | SE | ST | MLB |
|---|---|---|---|---|---|
| Margin analytics | | | ✓ | ✓ | ✓ |
| Derivatives counterparty risk | ✓ | | ✓ | ✓ | |
| Credit modeling | ✓ | ✓ | ✓ | ✓ | ✓ |
| Credit portfolio management | ✓ | ✓ | ✓ | ✓ | ✓ |
| Risk-aware accounting | | | ✓ | ✓ | ✓ |
| Fraud analytics | ✓ | ✓ | ✓ | ✓ | ✓ |
| Credit trading | ✓ | | ✓ | ✓ | |
| Credit-adjusted credit and balance sheet optimization | | | ✓ | ✓ | ✓ |
| Retail credit scoring | ✓ | ✓ | ✓ | ✓ | ✓ |
| Behavioral analytics | ✓ | | ✓ | ✓ | ✓ |
| Credit control and limits management | ✓ | | ✓ | ✓ | ✓ |

*ML: machine learning; GA: graph analytics; SE: simulation engines; ST: stress testing; MLB: market-linked behavioral analytics*
*Source: Chartis Research*

stress testing) are increasingly being leveraged for banking-book frameworks.

Overall, the credit risk market has experienced transformational growth (see Table 2). However, the impact of different credit analytics and credit flow processes on market growth, technology and data varies. Risk-aware accounting has encouraged huge market growth, for example, with a corresponding need for data management and sourcing for compliance.

## The banking book revolution continues – and accelerates

Credit and credit analytics have progressively become more sophisticated, triggered on the banking book side – as we have seen – by IFRS 9 and CECL. These standards are also ushering in growing complexity of accounting and the overall finance function. Under IFRS 9 and CECL, and the internal ratings-based approach (IRB), forward-looking impairment modeling is becoming standard, exposing the banking book to a new suite of credit models that include probability of default (PD), loss given default (LGD) and exposure at default (EAD). The banking book lacks the legacy of modeling and analytical frameworks of the trading book, and its theoretical foundations are newer and less standardized.

In some specific contexts, the crossover of theoretical foundations developed from traded credit markets (specifically securitization) can be leveraged for banking-book assets and banking credit portfolio management. Increasingly, the risks and pricing profiles of traded credit markets in US consumer credit models are linked in hybrid frameworks to traded prices in the US securitization market.

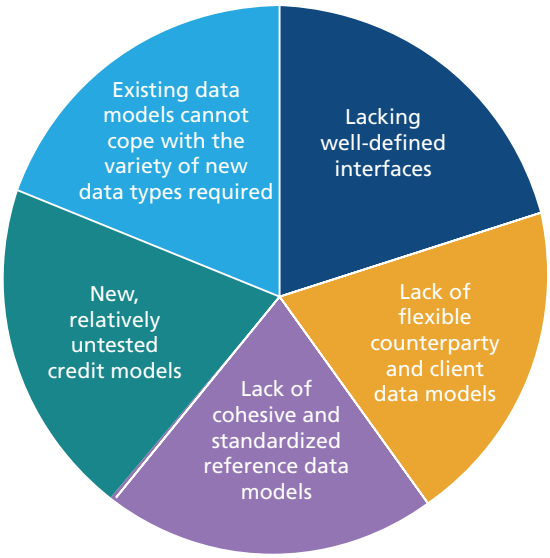
Overall, in effect, IFRS 9, CECL and Basel IV/FRTB have blown the credit modeling environment wide open (see Figure 6). This has exposed many technological and data challenges, and highlights the lack of standardization of data, modeling approaches and analytical frameworks within and across banks.

**Table 2: Impact of different credit analytics and credit flow processes**

| Credit analytics/credit flow process | Market growth | Technology impact | Data impact |
|---|---|---|---|
| Margin analytics | ● | ● | ● |
| Derivatives counterparty risk | ● | ● | ● |
| Credit modeling | ● | ● | ● |
| Credit portfolio management | ● | ● | ● |
| Risk-aware accounting | ● | ● | ● |
| Fraud analytics | ● | ● | ● |
| Credit trading | ● | ● | ● |
| Credit-adjusted credit and balance sheet optimization | ● | ● | ● |
| Retail credit scoring | ● | ● | ● |
| Behavioral analytics | ● | ● | ● |
| Credit control and limits management | ● | ● | ● |

● *High impact;* ● *Medium impact;* ● *Low impact*
*Source: Chartis Research*

**Figure 6: IFRS 9, CECL and Basel IV/FRTB have blown the credit modeling environment wide open**




*Source: Chartis Research*

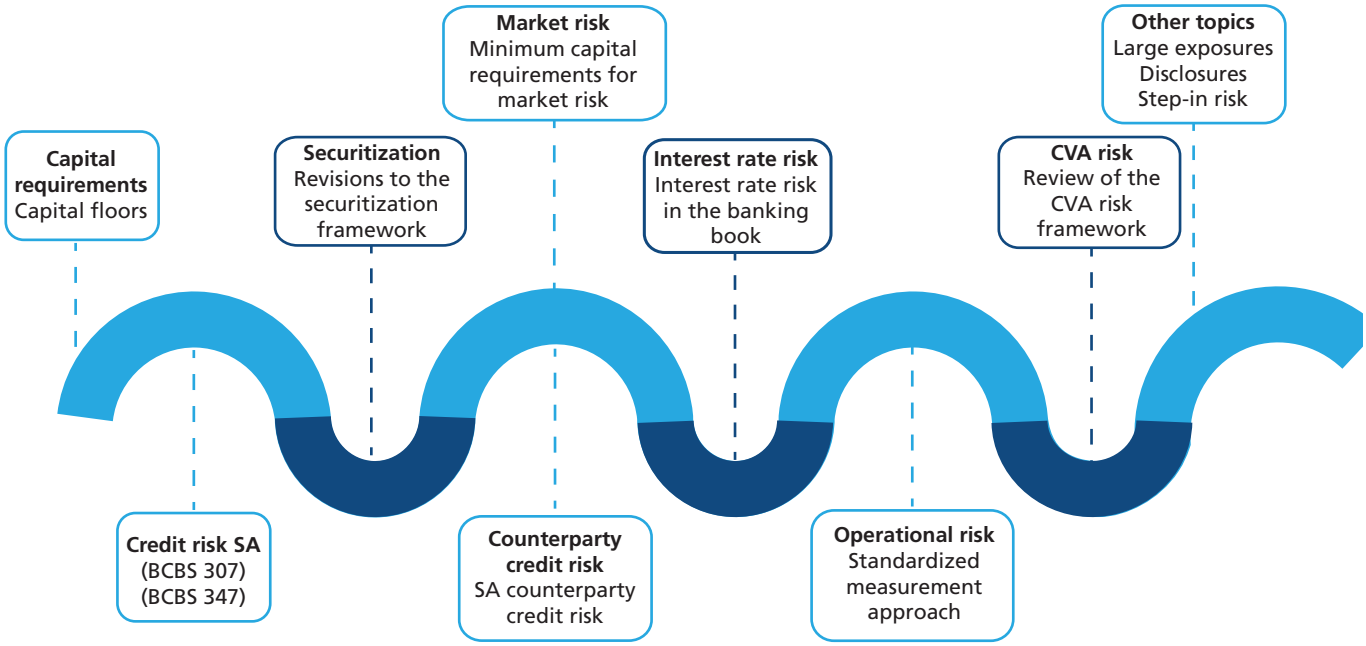
### *Standardizing methodology in the face of complexity*

Regulation and accounting standards have driven the development and implementation of a wide variety of idiosyncratic credit models. The banking book revolution has impacted separate asset classes in different ways, with the result that different methodologies are required for each. The growth patterns of credit analytics for banking also continue to diverge along regional and business lines.

The banking book revolution is happening against a complex backdrop of supporting technologies that underpin the credit risk market. The impact of new technologies is lowering the barrier to entry in the areas of computing, data management and open-source software.

In the face of all this complexity, firms are striving to achieve methodological standardization across the market, building models on fewer assumptions, making them more easily comparable, and making their output more defensible.

**Figure 7: Regulatory headwinds – from Basel III to Basel IV/FRTB**




*Source: Chartis Research*

***The transition from Basel III to Basel IV/FRTB – driving complexity***

The transition from Basel III to Basel IV/FRTB will have a big impact across the credit landscape (see Figure 7). Basel IV/FRTB, the latest instalment of regulatory reform for capital adequacy from the Basel Committee on Banking Supervision (BCBS), builds on Basel III, and includes reforms to RWA calculations for credit, market and operational risk. It offers guidelines and rules on calculation methods and capital adequacy ratios. Depending on which rules affect them, FIs can use the standardized approach or the internal models approach when calculating capital requirements for credit risk.

Basel IV/FRTB, the reforms to Basel implemented in 2021, will significantly increase banks' capital requirements and the restrictions for calculating risk-weighted assets and capital ratios.

***Credit portfolio management – coping with complexity***

In recent years, credit portfolio management (CPM) has evolved from its traditional role as a reactive method for managing exposure at the level of individual loans and instruments. CPM is now applied much more expansively, driven largely by regulatory liquidity, margin and collateral requirements. Contemporary CPM involves a much broader application that includes risk attribution, sensitivity analysis and dynamic hedging. To facilitate this new broader application, CPM teams collaborate and share data with other functions in the institution in an unprecedented way.

In the context of regulatory headwinds and accounting standards, CPM has become a pressing concern for finance departments, especially as CPM shifts from loan portfolios exclusively to address the entire balance sheet. Strong links and collaboration between stakeholders are becoming essential.

CPM requires different methods of credit portfolio optimization, since it is not a 'one size fits all' process, but rather is driven by a variety of different and often contradictory requirements. These include regulatory variables, accounting standards and CPM industry standards, all of which must increasingly address a broad range of questions:

- What is the distribution of loss in my portfolio?
- What assumptions are being made when I derive the loss distribution?
- What does 'correlation' mean?
- What does the market tell me about credit risk?
- How do I allocate risk across the constituents of my portfolio?

- Which constituents generate the most return on risk – and which the least?
- How do changes in portfolio composition manifest themselves at portfolio level?
- How do I correctly price credit default baskets?
- How do I quantify and manage risk when I buy or sell tranches from baskets of CDOs, CLOs and credit-linked notes (CLNs)?

Current CPM systems must contend with the increasing breadth of required features and diverse contexts of application. They must also consider the diversity of regulations and accounting standards and the compliance strategies they will employ. Ideally, CPM platforms would be equipped with the full panoply of analytical methods that cover the entire set of regulatory and accounting standards.

But this can be challenging, because regulation and accounting standards diverge in many areas. Despite the common goal of credit optimization, under various regulations and standards restrictions, aim and scope can characterize processes very differently. Coverage of standards and regulations can affect different parts of a FI, for example (as highlighted by the focus of the standard initial margin model (SIMM) and Basel IV/FRTB-CVA on over-the-counter [OTC] derivatives). And while CCAR/EBA[4] stress tests focus on enterprise solvency, IFRS 9 largely impacts banking-book credit, while IFRS 13 affects derivatives accounting. Even within valuation adjustments, there can be significant divergence in the parameters and methods used for the calculations. For instance, the underlying mechanisms of regulatory CVA calculations differ from those used to calculate CVAs under accounting standards.

In short, CPM systems must address huge variation. To tackle these many different contexts, banks must essentially build a custom credit and CPM framework for each unique demand.

The demand for a tailored CPM approach by specific use case has created a clear demarcation of calculation types in the credit space. The outcome of the shift in CPM to broader and more bespoke approaches is that model categories have become much clearer and well-defined. They include:

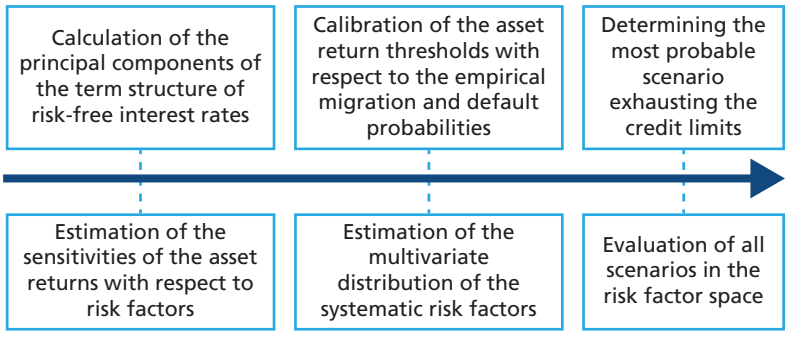
- Economic scenario generation (ESG).
- Simulation frameworks.
- Default risk engines.
- Reverse stress testing.
- Optimization.
- Contingent claims definitions.
- Definitions of managerial action.
- Behavioral analytics frameworks.

On the banking book side in particular, a standardized methodology has historically been lacking, and the trading book is comparatively more mature in this respect. Increasingly, as compliance burdens for the banking book continue to increase, those methodologies are being defined by accounting-standard boards and regulators. With clearer demarcation of model categories and their different compliance functions we are seeing the development of industry standardization, and across the banking book we are seeing a move to develop coherent and consistent modeling frameworks.

Nevertheless, the core mathematical components underpinning these techniques need to be reworked. For example, regulatory incidence[5] provides multiple constraints, and the structural models required for effective balance sheet management – such as reverse stress testing and Dodd-Frank Act stress tests – are well-known, albeit ill-defined in a banking book context.

Work is also needed on other elements of these techniques, from ESG, dynamic cash flow and simulation frameworks to stress and reverse stress testing, contingent claims definition and behavioral analytics frameworks. Figure 8 shows how reverse

**Figure 8: Defining reverse stress testing for credit portfolio management**




*Source: Chartis Research*

[4] *Comprehensive Capital Analysis and Review/European Banking Authority.*
[5] *The amount of regulatory oversight in a particular region, and the likelihood of fines.*

stress testing, for example, can be engineered to work for CPM.

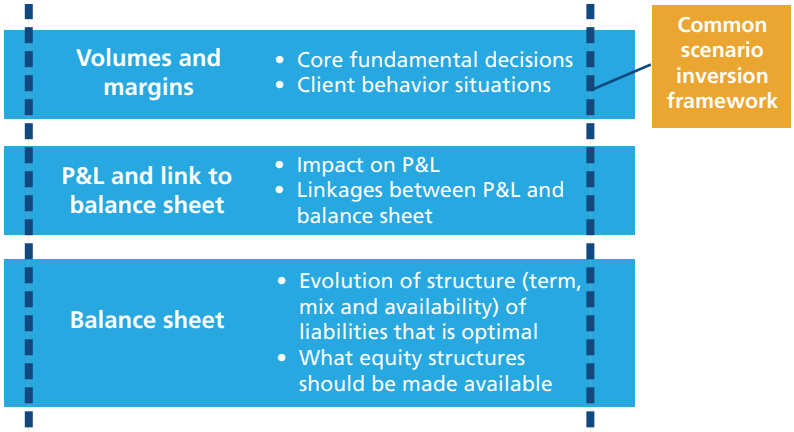
Figure 9 illustrates how this re-engineered process can then be applied to a credit portfolio to provide a higher order of analysis.

This form of integrated credit portfolio management, while conceptually and technologically challenging, is now an increasingly critical requirement for FIs. Figure 10 shows the asset classes and matching analytical frameworks for integrated CPM.

A significant element in the emergence of broader and more exhaustive CPM industry standards is the increased expectation of regulators and accounting bodies around stress tests. CCAR/EBA, Basel capital adequacy, IFRS 9/13, SIMM and Basel IV/FRTB-CVA have all contributed to greater scrutiny of stress testing. More than ever, banks must work to create stress testing frameworks that cover the specific demands of different regulations and standards.

The disparate methodologies of simultaneous stress testing regimes generate different results and have different reporting and disclosure timelines. Accounting standards like IFRS 9 and IFRS 13 require relatively frequent stress testing, compared with CCAR/EBA, which is conducted annually. While it is vital that FIs structure their stress testing frameworks so that they adhere to different compliance demands, they must also reconcile the varying results within the institution, to create a consistent view of their balance sheets under different stressed events. With a consistent view of their stress-testing data, firms will be able to make informed decisions in the event of a stressed condition, then mitigate their strategic risk to preempt it.

**Figure 9: Extending reverse stress testing to credit portfolio management provides a more sophisticated style of attribution analysis**




*Source: Chartis Research*

ML has been of particular benefit in reconciling and improving the quality of stress-test results. ML is especially effective for feature extraction and data clustering, enabling FIs to standardize data processes and achieve consistency across their stress-testing frameworks.

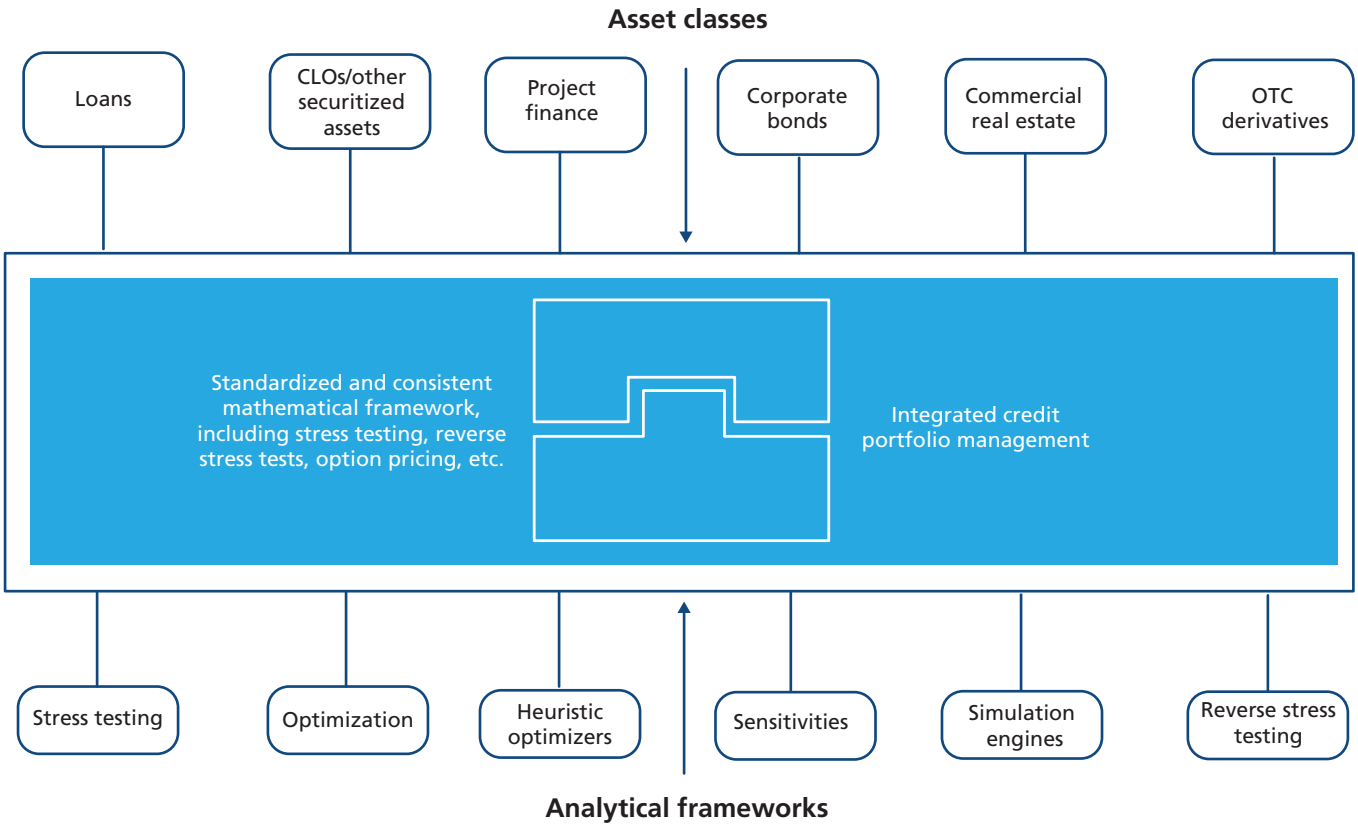
In the banking book in particular, ML is helping FIs cluster, classify and wrangle sparse or limited data sets (see Table 3).

**Table 3: Machine learning in banking book credit**

| Clustering | Classification | Dealing with sparse or limited data |
|---|---|---|
| • Segmenting accounts by behavior.<br>• Segmenting accounts by balance rundown (NMDs*), prepayment rates (mortgages) or roll rates (term deposits).<br>• Model-based clustering for coordinated segmentation and model fitting in behavioral modeling.<br>• Separation of stable and non-stable accounts.<br>• Application to segmentation and modeling of NMDs. | • Relation of behavioral types to features.<br>• Associating account characteristics with behavioral segments.<br>• Links to predictive modeling, using features to predict behavior. | • Ability to combine or enrich prior information with data, however sparse.<br>• Prior information may be expert judgements, contractual information, or a model for a similar product with better data. |

** Non-maturity deposits*
*Source: Chartis Research*

**Figure 10: A standardized and consistent mathematical framework for CPM**




*Source: Chartis Research*

**Figure 11: Front office requirements differ from those of credit control and accounting**

| Function | Model focus | Process features | Speed and calculation features |
|---|---|---|---|
| Credit control requirements | • Regulatory focus. | • Approximation of appropriate front-office pricing models.<br>• Model discrepancies can be handled through (conservative approach to exposure). | • T+n calculation. |
| Front office requirements | • Front-office managed model and calibration (calibrated to market). | • Accurate pricing is critical: if risk is priced too high, client will not trade. If risk is priced too low, the trade will not be profitable.<br>• Incorrect pricing of xVA results in incorrect hedging. | • Real-time, pre-deal limit checking requirement (sub-millisecond for electronic trading).<br>• Ability for sales/trading to quote xVA charges in real time at the point of trading. |

*Source: Chartis Research*

## Trading book - credit analytics

In the trading book, credit analytics have a long legacy of methodological evolution. Nevetherless, credit risk on the trading book has a variety of aspects that are becoming progressively differentiated, with fewer overlaps in calculation methodology. CVA (and contingent credit analytics) in particular is a defined, separate area of credit risk calculation, with a distinct methodology; CVA calculations have become an entrenched part of derivatives pricing.

### *Contingent credit and xVA*

Contingent credit modeling and CVA frameworks have relatively well-developed and stable methodologies that have been embedded in the process of derivatives trading. However, there has been a deep, structural change in the underlying technologies involved, largely in an attempt to improve computational efficiency. As well as the underlying technology, the delivery mechanisms are changing, and the role of programing languages such as Python is growing. Python has effectively triumphed in the capital markets, where Python-based frameworks are becoming the core standard for xVA systems, providing sophisticated capabilities for CVA analytics. They are also increasingly making their way into the banking book.

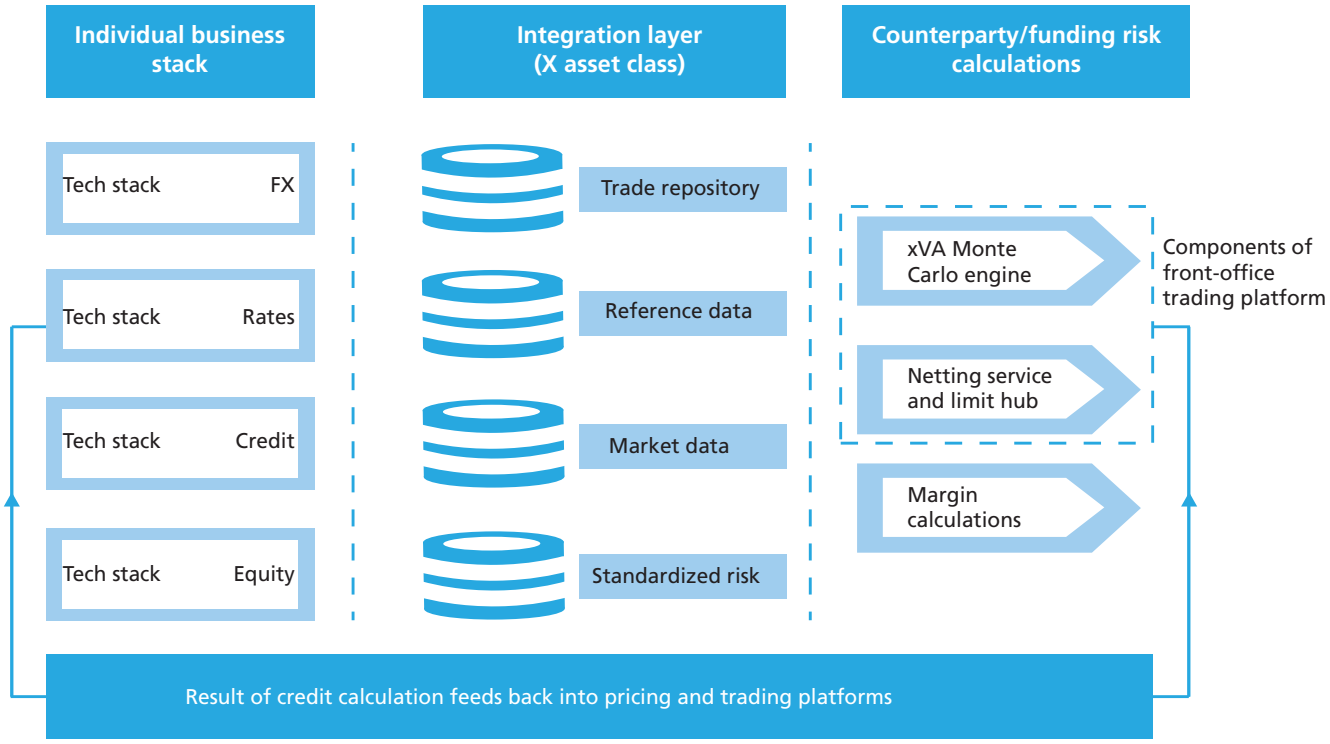
There are many flavors of xVA, since front-office requirements differ considerably from credit control and accounting requirements. Technology solutions must be able to support the distinct requirements of xVA, depending on whether the adjustments sit in the front or back office (see Figure 11).

Table 4 provides a more detailed breakdown of xVA requirements for a selection of core risk measures.

The architectural framework for xVA is silo-driven, and as such requires an integration framework. Figure 12 illustrates the interplay of these components across business lines, integration layers and risk calculations.

The trend toward integration is driving investment decisions in contingent credit and xVA. Market-risk dashboards are an area of strong spend, for example, as the frontier of development moves away from web-based front ends to align more closely with the offerings of specific data firms. Table 5 identifies the varying levels of investment we are seeing in different areas of contingent credit and xVA.

**Figure 12: Silo-driven architectural framework for xVA**




*Source: Chartis Research*

**Table 4: Key xVA requirements by risk measure**

| Risk measures | Trading | xVA desks | Finance (valuations) | Front-office risk | Enterprise risk | Treasury |
|---|---|---|---|---|---|---|
| CVA | Focus on the impact on the trades-price taker | Focus on complex products | Focus on valuations impact: batch process; low performance impact | Focus on complex products | Completeness of coverage and performance. Focus on simpler models for flow products | Flow *and* complex products |
| DVA | Moderate | Moderate | Critical | Moderate | Moderate | Critical |
| MVA, CollVA | Price taker | Critical (but not universal) | Low impact | Critical (but not universal) | Moderate | Critical (but not universal) |
| Forward CVA | Impact on portfolio and 'what if' analysis | Useful | Low impact | Useful | Useful | Future impact |
| FVA – cost and benefit (including funding and close-out netting) | Impact on portfolio and 'what if' analysis | Critical (but not universal) | Critical | Critical (but not universal) | Critical | Critical |
| KVA | Useful | | Low impact/ evolving | | Useful/evolving | Useful |
| Technology considerations | UI, visualizations, workflow, dashboard | Focus on accurate hedging and P&L analysis. Sympathetic to AAD. GPUs and data parallel may force rewrite of core pricing | Rules engine; computational requirements relatively modest | Focus on accurate hedging and P&L analysis. Sympathetic to AAD. GPUs and data parallel may force rewrite of core pricing | Performance due to vast flow requirements; strongly sympathetic to GPUs and other hardware-driven platforms | Focus on accurate hedging and P&L analysis. Sympathetic to AAD. GPUs and data parallel may force rewrite of core pricing |
| Methodology focus | Low | High | Low | High | Moderate | High |

*Source: Chartis Research*

***Regulation and accounting – CVA perspectives***

The two main compliance drivers of CVA calculations include the Basel accords (regulations) and the IFRS standards. Both deal with counterparty credit risk, but do so from different perspectives. Under Basel III/IV, the CVA calculation informs the capital requirements banks must provide in relation to their counterparty risk exposure. From an IFRS accounting perspective, the intention of the CVA is to produce the fair value of an OTC derivative portfolio to report to the P&L. Having respective and differing approaches to CVA calculations creates a mismatch in the CVA, as both approaches are based on different parameters.

As a fair valuation, CVA accounting calculations must be based on the expected exposure at the measurement date. From a regulatory perspective, stressed circumstances must be taken into account, creating a more conservative value. They also both depend on different data inputs. For accounting, CVAs must be calculated using market-implied data such as credit-default swap (CDS) spreads. Under Basel, however, banks are free to use historical data.

***Basel IV/FRTB-CVA revisions***

The changes to the existing Basel rules on CVA, agreed in 2016/17, are known as Basel IV or FRTB-CVA. The amendments restrict the use of banks' internal models when they calculate CVAs. More basic approaches are set to replace the old system of advanced (internal model approach) and standardized approaches. Less sophisticated banks will have to use the basic approach and take on the higher capital charges. Banks opting for the more risk-sensitive standardized approach will have to qualify for it, and show that they can calculate adequate CVA sensitivities. Under Basel IV, the sensitivity of CVAs to market risk and credit-spread risk incurs a CVA variability charge that requires banks to hold capital relative to CVA volatility (see Figure 13).

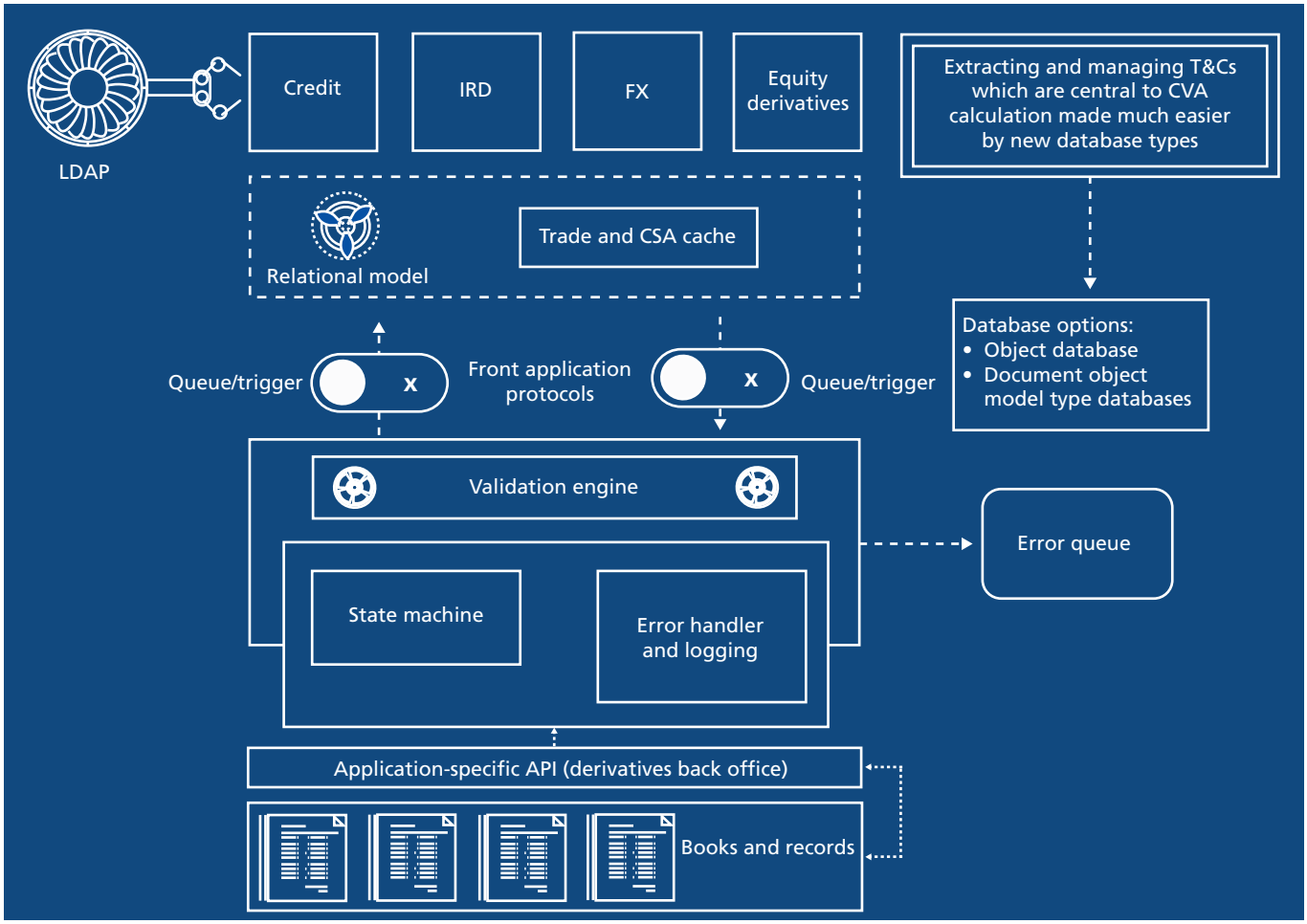
The reforms brought in by FRTB-CVA are pushing banks to adopt clearer methodological practices, in line with emerging industry standards. The

**Table 5: Key areas of investment in contingent credit/xVA**

| Spend | | |
|---|---|---|
| Front-end dashboard | ● | Market risk dashboards are a strong area of spend. Technology changes are moving the frontier of development away from web-based front ends toward the desktop, aligining closely with the offerings of specific firms. |
| Collateral management | ● | Collateral management systems are high-growth, both on the trading and banking book sides. |
| Market data management | ● | New types of data and new datasets on standard obligors have made credit data management from third-party sources an area of critical growth. |
| Portfolio analytics and management | ● | Early stages of development, set for rapid development. |
| Data distribution and management | ● | Internal data distribution and management. |
| Calculation environment | ● | Core compute environment, increasingly HPC-oriented. |
| Result data cube and data warehouse | ● | Object databases. |
| Facility constraints management | ● | Extended entity data models. |
| Over limits workflow and processing | ● | Limits engine for the banking book is largely a commodity. |

● *High impact;* ● *Medium impact;* ● *Low impact*
*Source: Chartis Research*

**Figure 13: T&C CVA extraction**




*Source: Chartis Research*

actual calculations of CVA sensitivity for SA-CVA calculations and for counterparty netting agreements can be computationally intensive (see Figure 14).

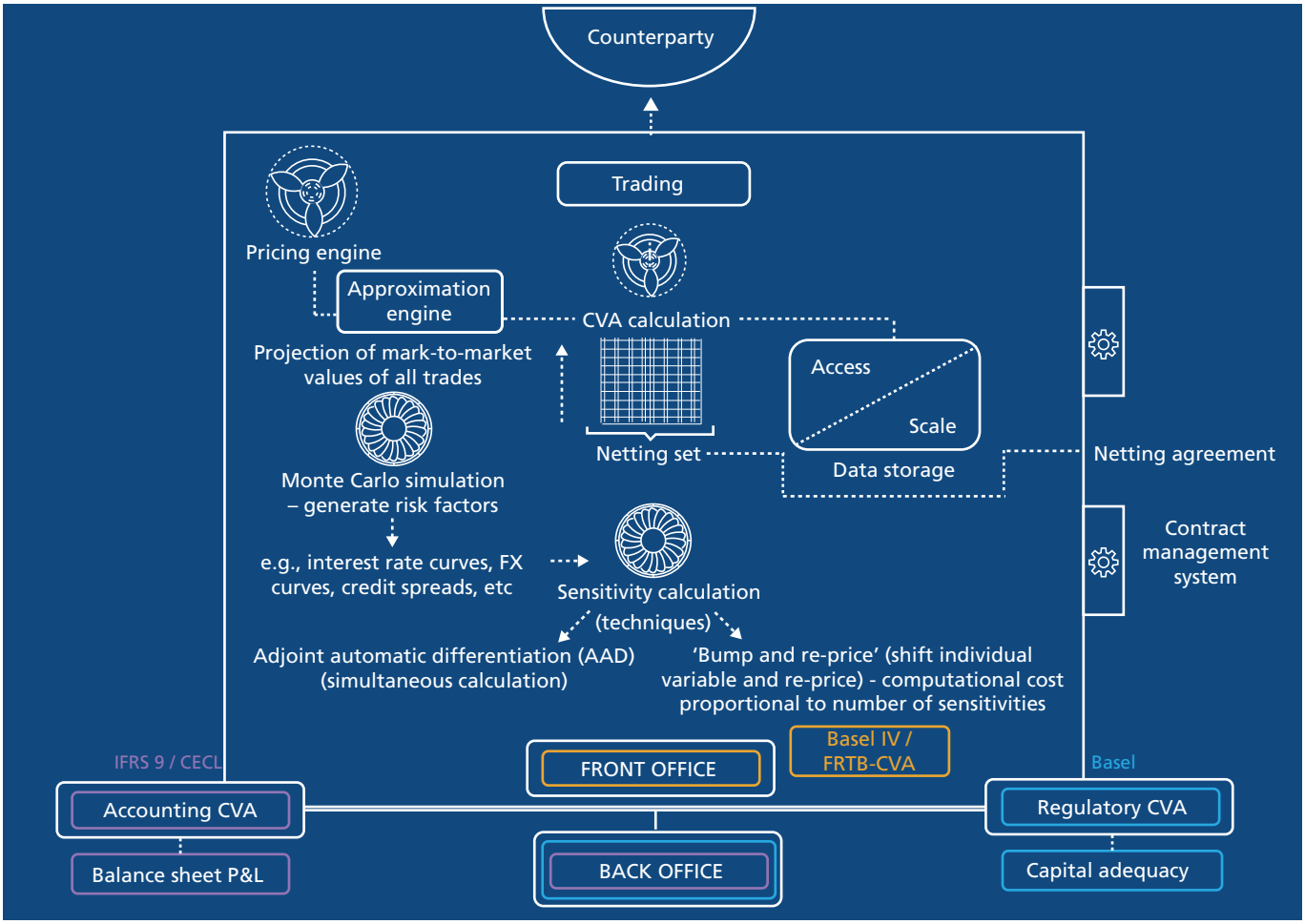
Traditionally, risk sensitivities have been calculated using the 'bump and re-price' technique. The 'bump' technique requires a revaluation every time an underlying risk factor is tweaked, generating a calculation each time. As banks have to run thousands of simulation sensitivities, this is computationally inefficient. The alternative approach, which uses AAD, calculates risk sensitivities simultaneously, and can be up to 1,000 times faster than the bump and re-price technique. However, the implementation of AAD can be challenging, because programming techniques must be recalibrated – a task many practitioners are unaccustomed to.

***Traded credit 2.0***

The CLO market is in the middle of a strong period of growth. Unlike its counterpart for CDOs, the CLO market not only survived the fallout of the financial crisis, it has thrived, more than doubling in value since 2010 to $660 billion in the US. CLOs are a form of structured product, composed of spliced loans organized into credit risk tranches, and function as a way to help members of a syndicate loan to businesses, gather returns and manage risk. A bank will aggregate a group of business loans and sell them to a syndicate of CLO buyers.

CLOs are organized into tranches with different loan cash flows based on the risk appetite of the CLO buyer. The lower the risk appetite (those buyers in higher tranches), the lower their potential interest pay-off. In the case of defaults and lower overall cash flows, however, higher tranches are entitled

**Figure 14: The three CVA perspectives**




*Source: Chartis Research*

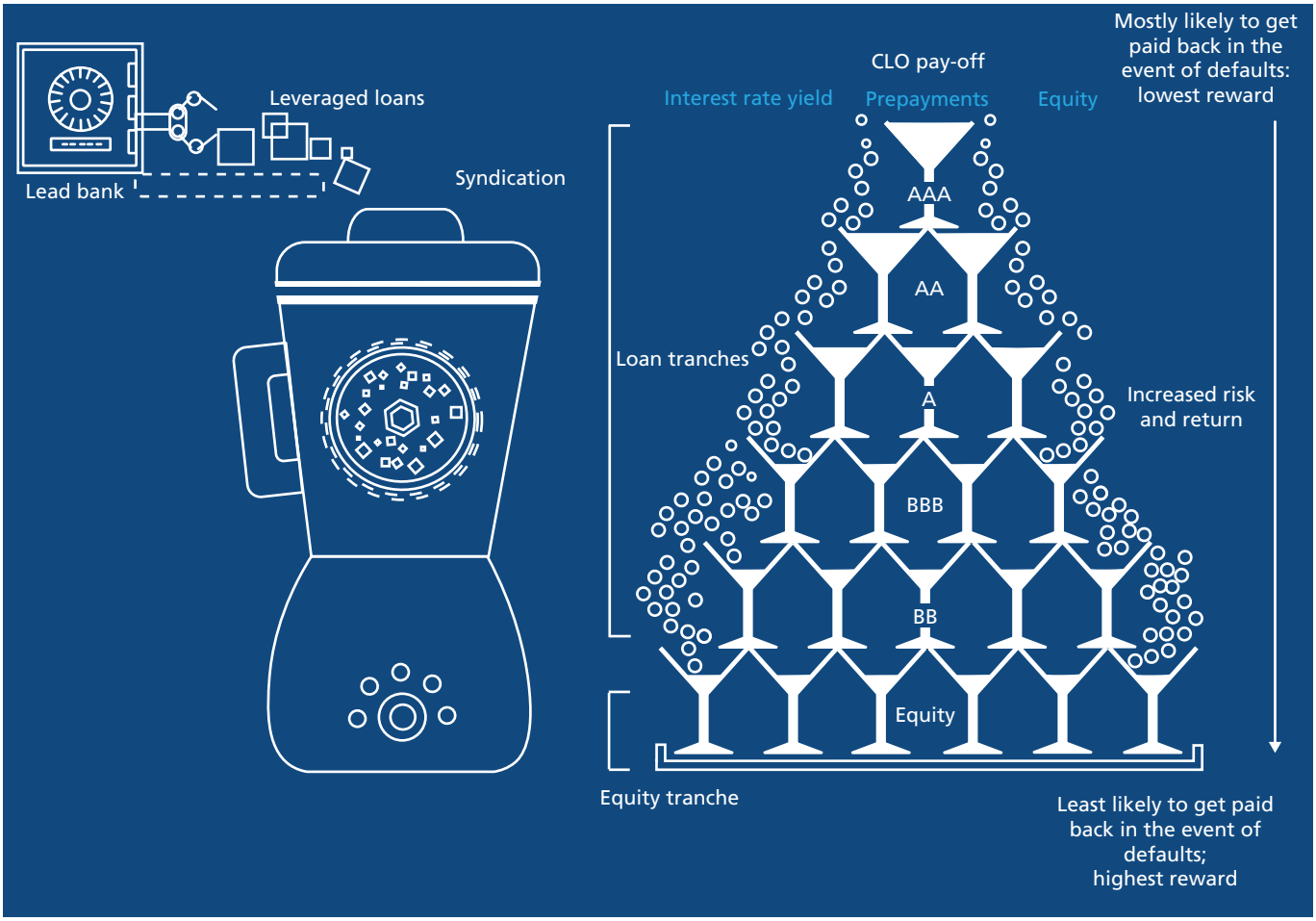
to returns relative to their position first. In essence, the greater the risk a buyer takes, the higher their potential yield – but the lesser their protection from adverse conditions that limit cash flows.

Recent accounting rule changes, such as IFRS 9, require the fair valuation of securitizations such as CLOs (see Figure 15). CLO portfolio valuation is a challenge, especially as the underlying collateral pool creates a multitude of necessary cash-flow calculations based on complex credit and payment projections. Determining the fair value demands the calculation of the PD and the correlation of default between loans. FIs can make these calculations either using a constant default rate (CDR) or by modeling them stochastically using tools such as Monte Carlo simulation. Market data for default curves is often not readily observable in the market, and default curves are often based on bond spreads or CDS spreads. The interest rate used in discounting is based on a floating rate, usually the London Interbank Offered Rate (LIBOR); however, that will now have to switch to alternatives[6] (such as the Secured Overnight Financing Rate [SOFR]).

More corporate credit data is now available, shining new light on what was historically a relative black hole in terms of transparency. Likewise, a blend of private loan data and bond data is now giving traders better insights, allowing them to model entire corporate structures more easily. However, constructing credit curves in illiquid assets remains a challenge, making it difficult to develop and maintain a coherent picture.

[6] **https://www.morganstanley.com/ideas/libor-its-end-transition-to-sofr**

**Figure 15: CLO product structure**




*Source: Chartis Research*

## Credit analytics take center stage (2)

In various ways, then, virtually all aspects of the credit management lifecycle have been substantially impacted by this revolution in credit. Changes right across the credit value chain have created a whole new credit risk management environment. Figure 16 illustrates the specific impact of a discrete set of new analytics on different areas of the data and analytics landscape.

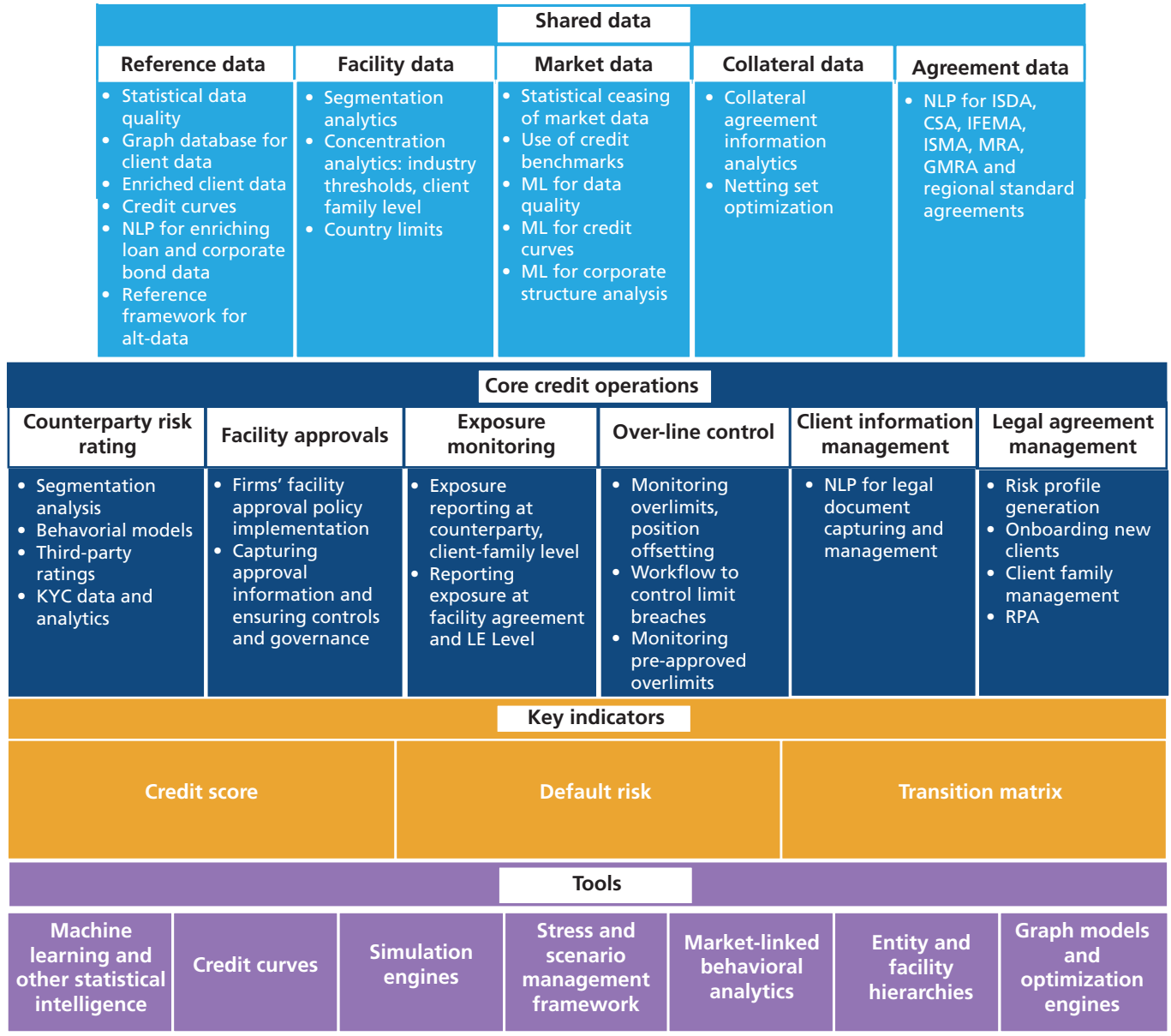
The impact of IFRS 9 in particular has been multifaceted, involving new product approval, origination, trade capture, structuring, hedge accounting, reporting and capital management approaches. In response, complex FIs have adopted several strategies, using either multi-vendor solutions, integrated solutions that leverage internally developed systems, or a combination of both approaches.

Elsewhere, behavioral dynamics have become increasingly embedded within banking credit models and CPM tools. These models leverage data around the implied risks of traded assets – specifically securitized retail products. Prepayment data suppliers' ability to leverage this data is principally why we are seeing such strong sales of their models to retail and commercial banking clients.

While behavioral models fall into a wide variety of statistical approaches and frameworks, typically they each fit into one of four categories:

- Traditional statistical models.
- Neural networks.
- Option-theoretic frameworks.

**Figure 16: Mapping the impact of new analytics on data and operations**




*Source: Chartis Research*

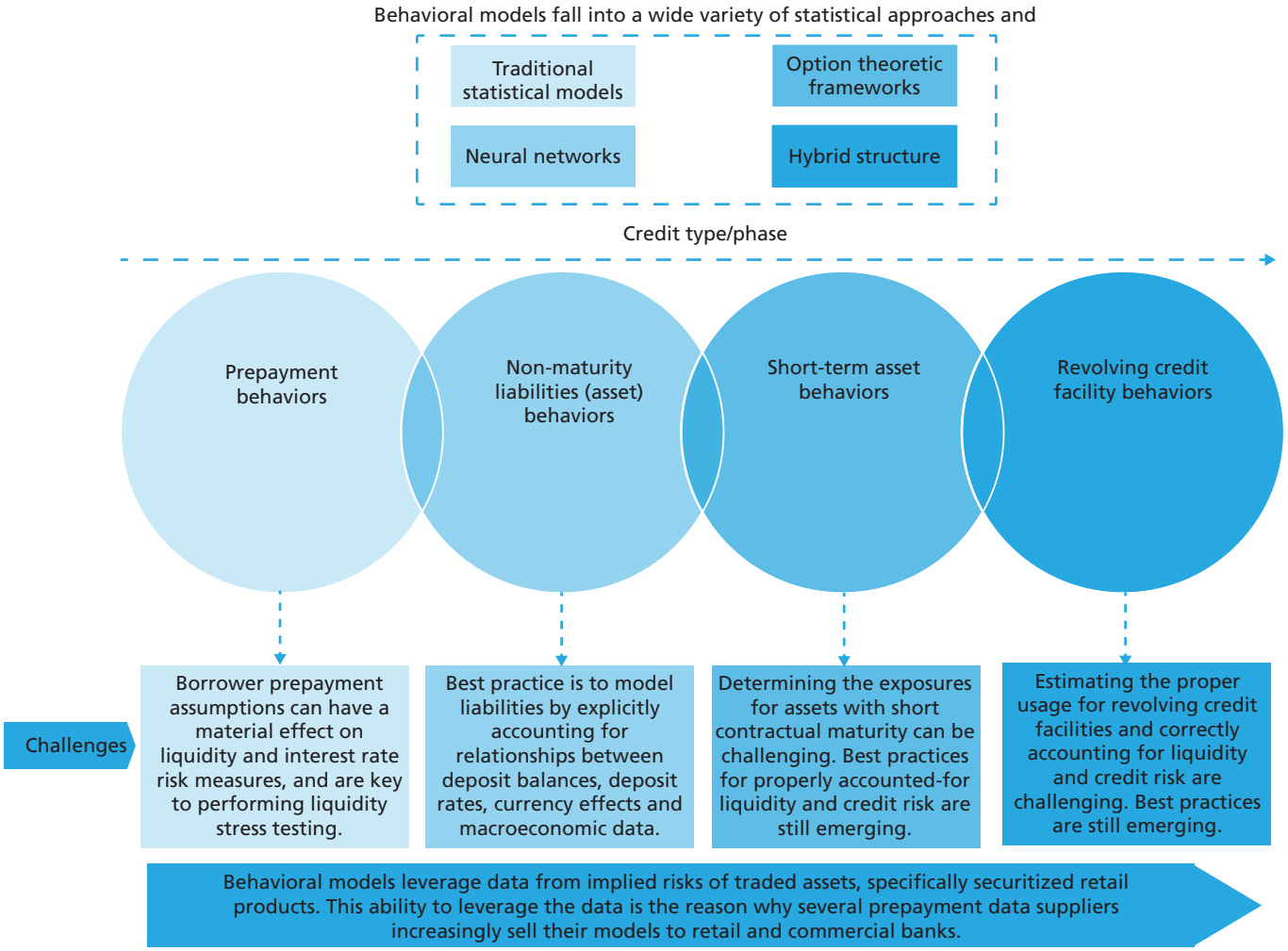
- Hybrid structures, incorporating some or all the above.

Figure 17 highlights some of the challenges facing firms with different behavior types, and how they are impacted.

Nevertheless, despite these challenges, behavioral modeling is a notable success story, particularly in retail banking use cases. In a recent survey conducted by Chartis, we asked respondents where they felt AI implementations had most value in risk management in retail banking. Behavioral modeling was, by some margin, perceived as the greatest source of opportunity in retail banking (see Figure 18).

Accounting standards, regulation and industry practice have set every institution on a credit risk management journey. Even within the business, different segments, like the banking book and the trading book, are at very different stages of credit risk management. Our credit risk management

**Figure 17: Different behaviors, different challenges**




*Source: Chartis Research*

roadmap, shown in Figure 19, identifies the progressive key stages of maturity.

## The 'new world' of credit data

The revolution in credit has opened up the banking book to a new suite of advanced credit analytics, and catalyzed a trend of standardization in methodology across the trading and banking books. The revolution has also triggered a more expansive industry standard for CPM, with clearer categorization of modeling techniques and their use cases. The credit revolution has affected different segments of the credit space, including wealth management and the traded credit markets, in unique ways. And underpinning all these market dynamics is a growing demand for data.

FIs are increasingly demanding new data sources to support the analytics driving the revolution, and to meet the requirements of new and more rigorous accounting standards. Much of the growth we are seeing has come in two discrete areas: consensus data and alternative data.

In effect, **consensus data** pools banks' internal credit ratings and delivers them as an aggregated set of risk ratings. **Alternative data** includes any and all data beyond that found on traditional balance sheets and cash-flow statements.

Table 6 identifies the benefits and challenges associated with both key data types.

A coherent data strategy is also central to IFRS 9 and CECL frameworks. Because of the regional contexts in which they operate, IFRS 9 and CECL present

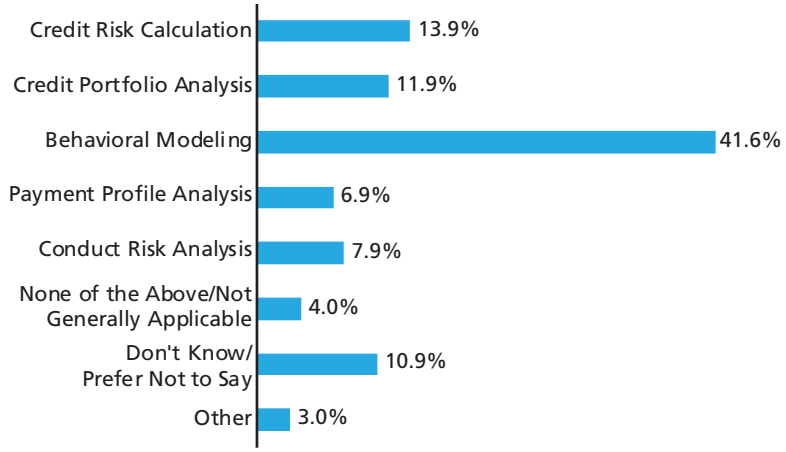
very different compliance data challenges. Markets in EMEA that fall under IFRS 9 are defined by a lack of data for impairment modeling, and FIs have to rely on assumptions derived from proxy data.

By contrast, US markets under CECL operate in a data rich environment created by the large historical securitization market. FIs therefore have to contend with the burden of correlating banking-book products with securitization data for products such as mortgage-backed securities (MBSs). The US market also has a tradition whereby smaller firms have relied on shared data pools such as third-party data sources.

Under both CECL and IFRS 9, third-party vendor loan and credit data is key, as is that from industry associations. Sophisticated data management systems for storing, cleaning and manipulating data are also essential to ensure that FIs can run their desired models with the required flexibility and scale.

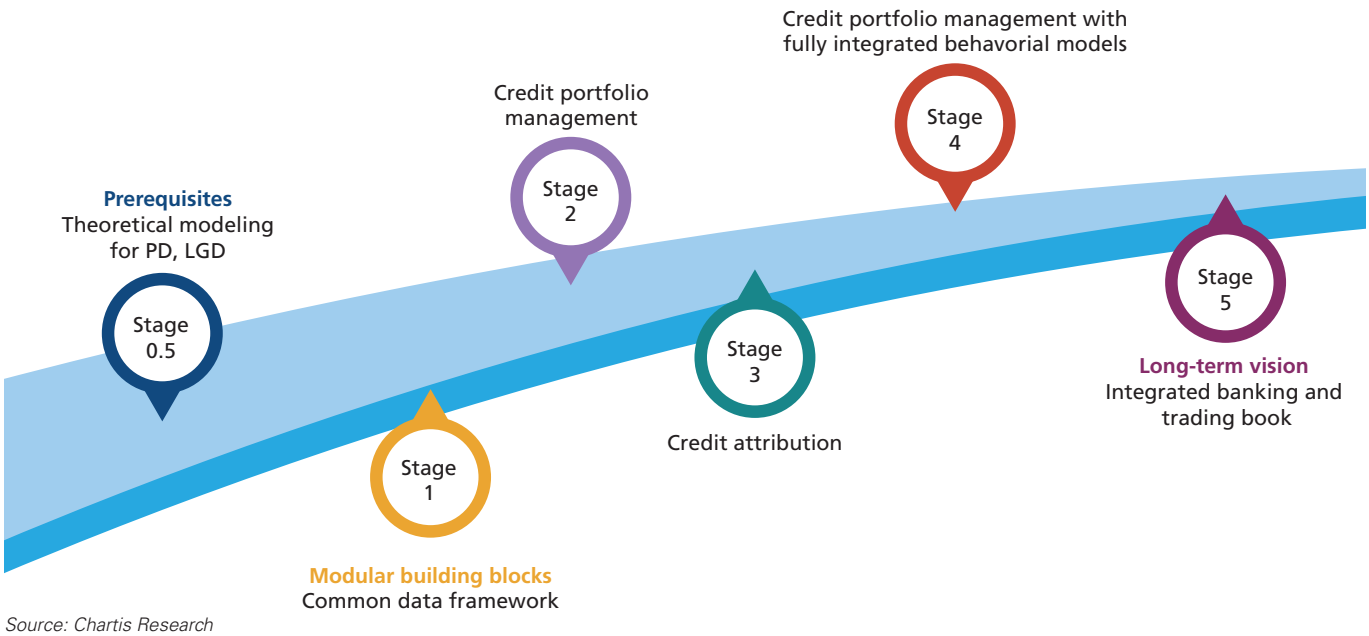
Looking ahead, firms should invest in data management systems and establish access to a core set of vendors that can supply data. Having a coherent strategy that integrates these suppliers will be important. Likewise, re-investing in, and re-examining, core credit processing platforms to ensure they can capture and store relevant information will be, in our view, mission-critical. Self-sufficiency is not the goal here. Rather, firms should define and implement a clear and well-articulated data strategy to deliver what they need. Figure 20 illustrates the interplay between different sources of data in a typical data distribution and management process for credit.

**Figure 18: Greatest perceived benefits for institutions in implementing AI tools for risk management in retail banking, by area (n = 101)**




*Source: Chartis Research*

**Figure 19: A potential roadmap for credit analytics**



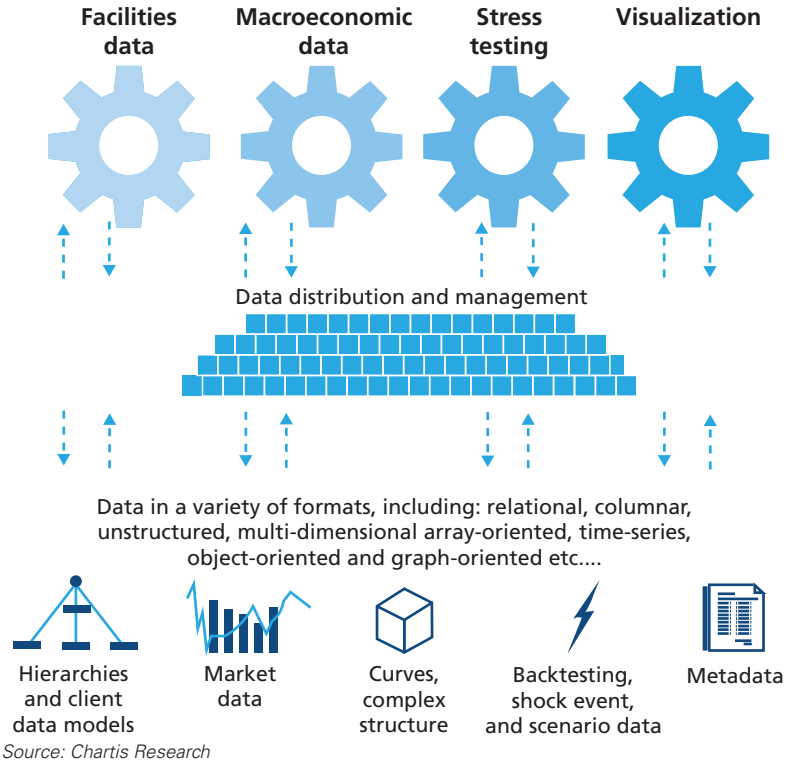

*Source: Chartis Research*

**Table 6: Credit data is changing, both in who is using it, and in how it is used**

| Alternative data | |
|---|---|
| **Benefits** | **Challenges** |
| Allows better segmentation of retail clients | Requires intensive validation and structuring, as well as integration with existing analytical systems and backtesting |
| Verifiable for trading book events due to their magnitude | Privacy concerns – some jurisdictions preclude use of alternative data |
| | Efficacy concerns – very high and very low creditworthy individuals will have least alternative data, biasing any sample |
| | Not yet relied on in a credit downturn – unsure how systems using alternative data will perform during systemic credit downturn |
| **Consensus data** | |
| **Benefits** | **Challenges** |
| Reduces reliance on issuer data | Concerns over aggregation and weighting – should some banks' ratings be weighted more highly? |
| Good for illiquid assets/names | Confirmation bias, false precision |

*Source: Chartis Research*

**Figure 20: Credit data is challenging to work with, so having a viable data strategy is key**




*Source: Chartis Research*

# 3. Vendor landscape

## Vendors continue to diverge

Vendors in each of the four segments of credit risk considered in this report – the banking book, the trading book (contingent credit and margin analytics), traded credit markets, and wealth management – remain diverse. They also differ considerably in their product offerings, penetration of various market segments, and their level of specialization. Few vendors have a presence in more than one sector – and even within sectors they generally offer distinct products. Within segments, product offerings remain component-based, and vendors that are analytically focused are increasingly diverging from more process-oriented players.

Theoretically, vendors could easily cross and overlap different market segments and sub-sectors, but in practice such a journey is not straightforward. Technologies and underlying methodologies cannot be easily transferred across segments and sub-sectors. Vendors' ability to widen their offerings is often constrained by methodological barriers, algorithmic variability, the existing technology context and the required data models. Different segments are also subject to varying regulatory requirements and stringency. The relative focus of different business groups and lines can also differ hugely.

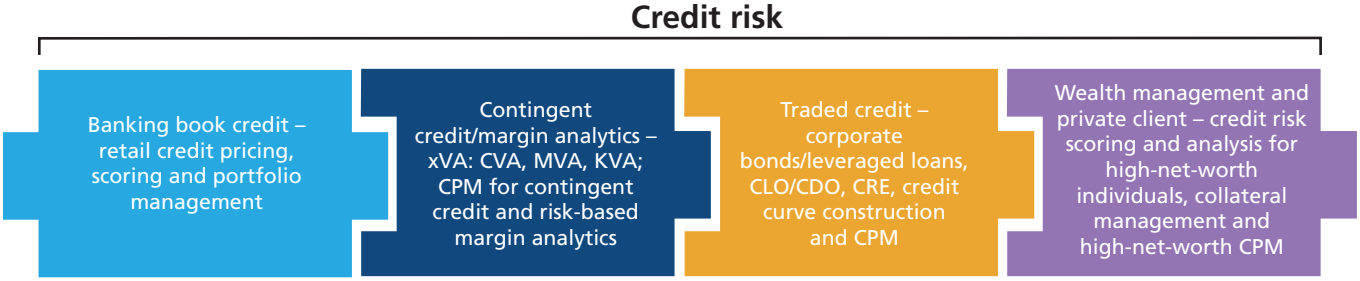
And while the overarching category of credit risk provides a useful market overview, in practice it is complex and varied. Credit markets and their analytics have fragmented into many sub-sectors, each requiring its own focused analysis. Each segment has sub-sectors with very different technology structures, data demands and consumers (see Figure 21). This market variation is mirrored in the vendor landscape – hence our focus on CVA and CLO markets.

## Recommendations for vendors – six steps to success

We advise vendors to do the following:

- Build and grow their analytics capabilities.
- Aim to have full analytically capable software suites, and depend less on their workflow capabilities. Credit markets are increasingly becoming analytically intensive. The banking book in particular has become progressively more analytically intensive, although that trend stretches across all credit risk market segments. In addition to widening analytics capabilities, vendors should focus on their analytical rigor – specifically in the banking book. Previously accepted standard modeling methodologies are no longer enough.
- Explore the possibility of leveraging neural networks and genetic algorithms, and orient them by use case, with a clear view of the underlying statistical underpinnings. AI techniques should not be a substitute for a lack of theoretical understanding or an inability to articulate the problem in question.
- Leverage open-source languages and their respective ecosystems. Open-source languages (such as Python, Julia and R) and their ecosystems provide a very broad range of core components that firms can use to accelerate the development of the mathematical models they need. They also provide a very strong base on

**Figure 21: Key functionality and products in different credit segments**




*Source: Chartis Research*

which to develop systems. The Python ecosystem includes a powerful array of programming environments (for building scalable computation environments), but it also includes fully fledged statistical frameworks. AI and ML development environments arrive heavily optimized, and can be rapidly leveraged to build an appropriate set of models.

Flexible and heterogeneous data systems are required to manage data, whether for the banking book, xVA, traded credit or wealth management.

Vendors should focus on leveraging the available data infrastructure, which has grown exponentially in recent years. Vendors looking to make a rapid shift out of their relatively constrained data framework have a variety of quick options for building scalable and computationally appropriate solutions. The database type a firm implements is important, and the database approach of most solutions will combine different approaches (such as NoSQL and SQL) to create an appropriate data infrastructure.

### Adopt a component-based approach

In this report we have emphasized how diverse and varied the credit space is. Vendors should reflect that diversity by providing highly componentized functionality.

### Emphasis on documentation, and a focus on standard/domain-specific languages (even internally)

As the theoretical rigor of systems increases, the number of components in solutions increases and sprawls, and data models grow heterogeneously, it is increasingly important that vendors develop detailed, well-structured and rigorous documentation of all application programming interfaces (APIs), models (including their validation, taxonomy and cartography), data models and messaging standards. In addition, from a design perspective, scripting engines should be replaced with domain-specific languages.

### Algorithmic rigor and technology alignment

There is a growing requirement for firms to be able to effectively and efficiently translate high-level modeling concepts into an implementation code. In essence this means that firms must focus on the rigor of intermediate algorithms, their supporting data storage, and the various utility functions involved. Equally, appropriate algorithmic alignment should be maintained.

## Chartis RiskTech Quadrant® and vendor capabilities for CVA solutions, 2020

### Quadrant commentary

Many strong players occupy the CVA space, and those with strong analytics capabilities in particular will thrive. Two key factors will differentiate stronger players:

- **Their operational coverage** – a vendor's capacity to cover the three CVA compliance areas: regulatory, accounting and trade pricing. One distinguishing feature of the strongest players in the CVA space is that they are implementing the AAD approach to calculate risk sensitivities simultaneously to improve calculation efficiency.
- **The efficiency of their sensitivity calculation approach**. Calculating risk sensitivity is a fundamental feature of risk attribution and CPM.

Access to market data (such as default data) is a core component of CVA functionality. How a vendor then integrates that data into system analytics via simulation engines can set it apart. As industry standards around CPM reach higher benchmarks (in terms of the overall expected quality of CPM), CVA P&L attribution functionality, for example, has become invaluable, and its importance has become a focus for banks.

Most vendors have relatively strong market potential and offer a breadth of functionality. In the CVA solution space, vendors' continued focus on analytics and algorithmic efficiency will secure them a place in the Category Leaders quadrant.

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

**Figure 22: RiskTech Quadrant® for CVA solutions, 2020**


*Source: Chartis Research*

**Table 7: Assessment criteria for vendors of CVA solutions, 2020**

| Completeness of offering | Market potential |
|---|---|
| • Asset class support | • Customer satisfaction |
| • Operational style coverage | • Market penetration |
| • Simulation engine | • Growth strategy |
| • Scalability | • Financials |
| • Sensitivity calculation | • Business model |
| • Market data | |

*Source: Chartis Research*

**Table 8: Vendor capabilities for CVA solutions, 2020**

| Vendor | Asset class support | Operational style coverage | Simulation engine | Scalability | Sensitivity calculation | Market data |
|---|---|---|---|---|---|---|
| Bloomberg | **** | ** | ** | *** | ** | *** |
| Calypso | *** | ** | ** | ** | ** | ** |
| Finastra | *** | *** | *** | *** | *** | ** |
| FIS | **** | **** | **** | **** | **** | ** |
| IHS Markit | *** | *** | *** | ** | ** | *** |
| Kamakura | *** | *** | *** | * | * | * |
| MSCI | *** | ** | ** | * | * | ** |
| Murex | **** | *** | **** | **** | **** | ** |
| Numerix | **** | *** | **** | **** | **** | ** |
| Quantifi | *** | *** | *** | *** | *** | ** |
| Quaternion | ** | ** | * | * | * | ** |
| SS&C | *** | *** | **** | *** | *** | ** |
| TriOptima | *** | * | ** | *** | *** | *** |
| Wolters Kluwer | *** | * | ** | ** | * | * |

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

## Chartis RiskTech Quadrant® and vendor capabilities for CLO solutions, 2020

### Quadrant commentary

The vendor space for CLO solutions is much more widely dispersed than that for CVA, and it is still evolving. The market itself has experienced massive growth in the past 10 years, but the complex nature of this particular structured product creates significant challenges for its analytics and their credit attribution calculations. CLO pricing doesn't have the same methodological history and stability as CVA pricing, although the increasing availability of corporate credit data has opened the market up.

Pricing itself is a challenge, and constructing credit curves is difficult in the face of asset illiquidity. CLO portfolio valuation requires vast amounts of data for cash flow calculations from the underlying collateral pool. The analytics developed to model the fair value of a CLO portfolio must be able to synthesize that scale of data and variables. Mature solutions will not only have strong data infrastructures, but also a wide variety of analytical tools. Key distinguishing functionality among solutions includes performance analytics and CPM, which enable users to gain competitive insight into the relative position of their CLOs and set benchmarks. CLO analytics can also enable users to create a profile of the manager's investment style and how that influences the CLO's performance.

Figure 23 illustrates Chartis' view of the vendor landscape for CLO solutions. Table 9 lists the completeness of offering and market potential criteria we used to assess the vendors. Table 10 lists the vendor capabilities in this area.

**Figure 23: RiskTech Quadrant® for CLO solutions, 2020**


*Source: Chartis Research*

**Table 9: Assessment criteria for vendors of CLO solutions, 2020**

| Completeness of offering | Market potential |
|---|---|
| • Collateral data analytics | • Customer satisfaction |
| • Pricing engine | • Market penetration |
| • Data infrastructure | • Growth strategy |
| • CPM support | • Financials |
| • Performance analytics | • Business model |
| • Reporting and visualization | |

*Source: Chartis Research*

**Table 10: Vendor capabilities for CLO solutions, 2020**

| Vendor | Collateral data analytics | Pricing engine | Data infrastructure | CPM support | Performance analytics | Reporting and visualization |
|---|---|---|---|---|---|---|
| Bloomberg | *** | ** | *** | ** | ** | ** |
| Fitch Ratings | ** | ** | *** | ** | ** | ** |
| IHS Markit | **** | ** | *** | ** | ** | ** |
| Intex | *** | *** | *** | ** | ** | ** |
| LPC Collateral | ** | ** | ** | ** | ** | ** |
| Moody's Analytics | **** | **** | *** | **** | *** | *** |
| MSCI | ** | *** | ** | ** | *** | ** |
| Quantifi | * | *** | *** | *** | ** | *** |
| RiskSpan | *** | ** | *** | ** | ** | ** |
| Thetica Systems | *** | *** | *** | *** | *** | *** |
| Trepp | **** | **** | *** | *** | *** | *** |
| VALITANA | ** | ** | *** | ** | ** | ** |
| Vichara | *** | **** | *** | *** | *** | *** |

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

# 4. Appendix A: RiskTech Quadrant® methodology

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

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

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

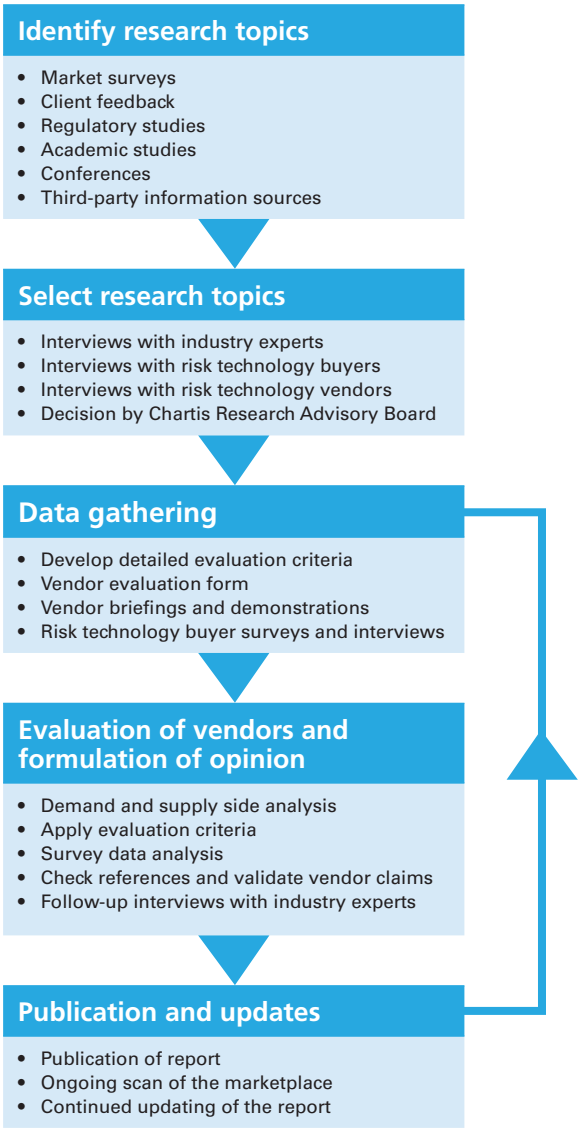
## Inclusion in the RiskTech Quadrant®

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

## Research process

The findings and analyses in the RiskTech Quadrant® reports reflect our analysts' considered opinions, along with research into market trends, participants, expenditure patterns, and best practices. The research lifecycle usually takes several months, and the analysis is validated through several phases of independent verification. Figure 24 below describes the research process.

**Figure 24: 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.

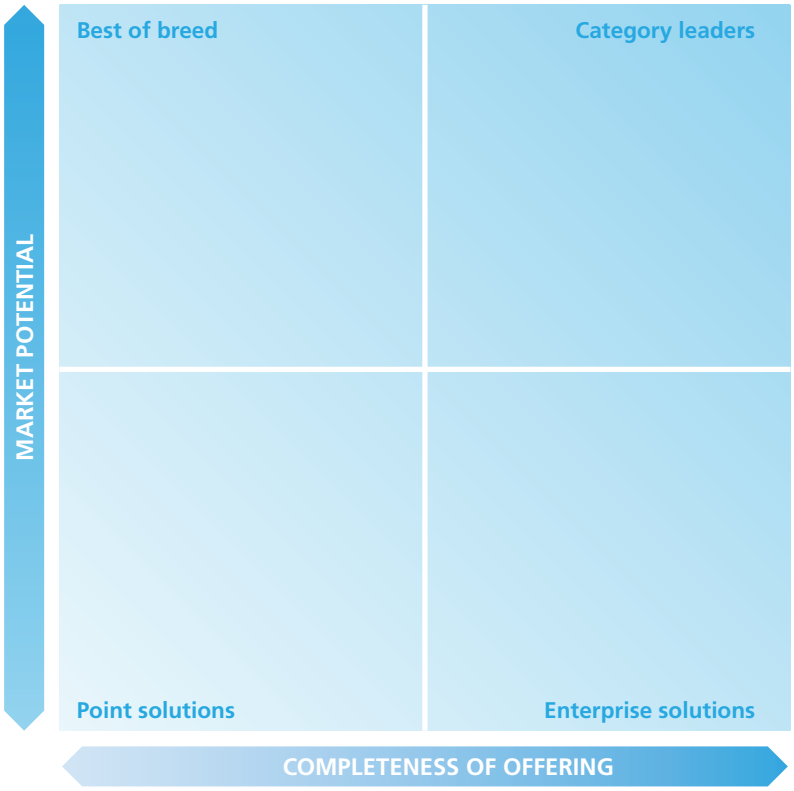
## Evaluation criteria

The RiskTech Quadrant® (see Figure 25) evaluates vendors on two key dimensions:

1. Completeness of offering

2. Market potential

**Figure 25: RiskTech Quadrant®**




*Source: Chartis Research*

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

## Completeness of offering

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

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

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

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

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

## Market potential

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

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

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

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

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

## Quadrant descriptions

### Point solutions

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

### Best-of-breed

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

### Enterprise solutions

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

### Category leaders

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

# 5. How to use research and services from Chartis

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

## For risk technology buyers

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

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

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

Our vendor selection services include:

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

## For risk technology vendors

***Strategy***

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

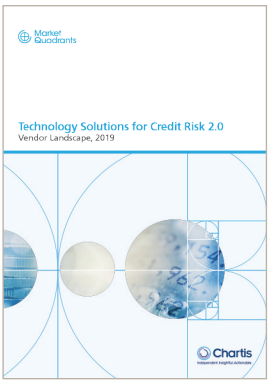
- Market analysis, including market segmentation, market demands, buyer needs, and competitive forces.
- Strategy sessions focused on aligning product and company direction based upon analyst data, research, and market intelligence.
- Advice on go-to-market positioning, messaging, and lead generation.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

***Thought leadership***

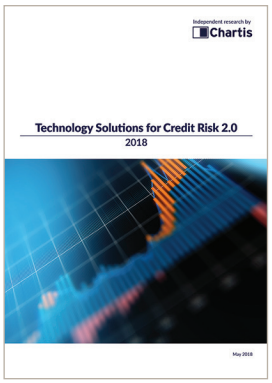
Risk technology vendors can also engage Chartis to provide thought leadership on industry trends in the form of in-person speeches and webinars, as well as custom research and thought-leadership reports. Target audiences and objectives range from internal teams to customer and user conferences. Some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

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

# 6. Further reading

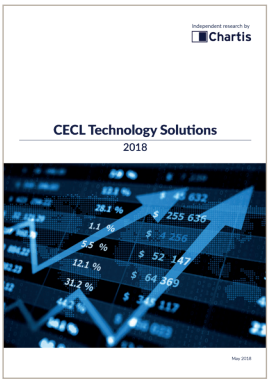



**Technology Solutions for Credit Risk 2.0: Vendor Landscape, 2019**



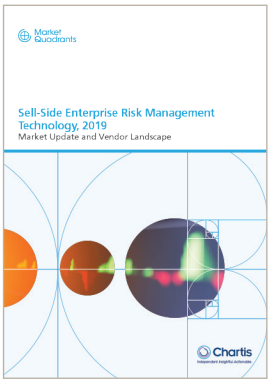

**Technology Solutions for Credit Risk 2.0, 2018**


**IFRS 9 Technology Solutions: Market Update 2017**




**CECL Technology Solutions, 2018**


**Fixed-Income Technology Solutions, 2019: Market and Vendor Landscape**




**Sell-Side Enterprise Risk Management Technology, 2019: Market Update and Vendor Landscape**

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