ENABLING ADVANCED RISK MANAGEMENT IN BANKING USING PUBLIC CLOUD

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Since the invention of the computer, the banking industry has aggressively pursued technology with the goals of creating competitive advantage and reducing costs. It is no surprise that banks and asset managers are aggressively embracing public cloud technology as they continue an industry-wide modernization effort that began after the 2008 great recession. One area where we believe there are significant gains to be achieved via the leverage of public cloud capabilities is in risk management.

Risk is nearly perfectly oriented for the use of the public cloud. Calculating risk is computationally intensive and requires burst compute capacity. It is also data heavy and good risk management requires a lot of data. Elasticity and managing massive data sets are two things the public cloud does extremely well.

Yet, the bulk of the public cloud adoption in banking has so far been focused on migration of non-critical applications to the cloud. The business cases that back these migrations are primarily based on reducing data center costs, rather than gaining competitive advantages via improving the effectiveness of critical workloads.

A key reason that financial services organizations are not moving critical workloads and data to the cloud is a perception that it is not secure. While potentially true three years ago, in the past eighteen months the major public cloud providers have invested billions of dollars in securing their environments. Based on this investment, it is difficult to argue today that when implemented correctly, a cloud-based application is not significantly more secure than the majority of ”on-premise” data centers currently run by the industry. The fact that numerous major institutions have been public about their plans for cloud migration underscores this point.

In risk management specifically, we expect the deployment of services provided by major public cloud vendors to become more common because they can enable capabilities that are nearly impossible to obtain using traditional, on-premises infrastructure. Advanced risk management requires massive computing power, which is difficult to achieve in a cost-effective manner without using the public cloud.
Over the past decade, risk management in financial services has come to rely heavily on technology to power analytics that are ever-increasing in complexity. Examples include the adoption of analytical software for pricing of complex financial instruments, the deployment of electronic trading and straight through processing and most recently leveraging of machine learning to support the business ability to meet client needs.

Part of the push for tech adoption in risk management has been based on regulatory requirements, driven by Basel, central banks, and other regulatory bodies. However, a significant portion of the impetus has been internal as both banks and investment managers race to derive competitive advantage from better analytical models that allow them to profitably and safely take on levels of risk that competitors cannot.

Much of the computational power in risk management goes to calculating key risk measures such as value-at-risk (VaR) and valuation adjustments (such as CVA and xVA 1), measuring credit risk, running stress testing, risk simulations, and portfolio construction algorithms. Today, much of this infrastructure is powered by on-premise systems, installed and maintained in the data centers of each individual financial institution.

The heavy use of on-premises infrastructure for risk management can generate significant costs due to periodic needs for modernization and upgrades, replication to meet business continuity and disaster recovery requirements, and limitations in the amount of burst compute power and storage that can be harnessed at any one point in time. This approach creates artificial limitations to what can be accomplished in risk management, an area that is heavily dependent on large quantities of on-demand computing power. New regulatory requirements such as the Current Expected Credit Losses (CECL) accounting standard have only expanded these needs.

The increasingly widespread adoption of machine learning to manage risk is also increasing the need for vast compute capability for training and running sophisticated models, both intra and end of day. The vast quantities of data that a machine learning model can absorb has also generated the need for flexible and expandable data architectures, leading to large, flexible data storage and processing requirements.

Many large financial institutions have recognized the opportunity offered by public cloud and are making tangible investments into migrating parts of their risk infrastructure. Currently, public cloud adoption across financial services is predominately focused IaaS, but we see advanced organizations starting to deploy PaaS and FaaS capabilities, especially in risk management where the business case is quite compelling.

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1 Credit Valuation Adjustment and x-Value Adjustment, respectively
THE FOUR CATEGORIES OF CLOUD ADOPTION

The adoption of public cloud is happening broadly in four different categories, with different financial services firms at different stages of adoption for a range of types of services.

SAAS
Software as a Service (SaaS) is a fully managed application platform under which a bank or asset manager plays no role in the design, deployment or management of the application. Nearly every vendor in the risk market offers a cloud-based SaaS deployment of their software and this model is often attractive to smaller risk management organizations with simpler requirements or reduced scale. Examples of SaaS include WorkDay and Salesforce.com.

IAAS
Infrastructure as a Service (IaaS) is the most common category of public cloud adoption. In this stage, public cloud infrastructure is primarily used to replace servers (compute) and file storage (persistence). Savings are realized by elastically expanding and contracting the amount of compute power required only when it is necessary to perform work, and by avoiding the necessity of constant data center hardware upgrades. Amazon AWS’s S3 storage and EC2 compute services are examples of IaaS.

More sophisticated organizations are also taking advantage of the graphical processing unit (GPU) and field programmable gate array (FPGA) capabilities that public cloud providers can deploy, capabilities that are directly applicable for complex risk management use cases.

PAAS
Platform as a Service (PaaS) is an increasingly more complex form of adoption beyond IaaS. In this area, banks and asset managers are deploying cloud native databases, in-memory cluster compute capabilities such as Apache Spark, container services, data transformation platforms and data visualization tools.

The list of PaaS based capabilities that the public cloud vendors are making available is nearly endless, and many of them have applications in data manipulation and storage, analytics, machine learning and visualization – all core aspects of sophisticated risk management.

FAAS
Framework as a Service (FaaS) is an additionally sophisticated form of public cloud adoption. In this stage, financial services firms are breaking away from renting clusters of servers and moving to “serverless” deployment of capabilities. In this model, the public cloud vendor provides a fully managed set of infrastructures that automatically scale as required to perform specific tasks.

Examples include databases that have built in resiliency and disaster recovery, machine learning training platforms that come with integrated workflow and deployment, managed container capabilities that abstract the complexity of scaling of open-source systems like Kubernetes. All of these capabilities have application in the deployment of sophisticated risk management functions.
ADOPTION BY THE SELL-SIDE

Sell-side capital markets firms have probably the most to gain in terms of shorter-term absolute returns from moving to the public cloud. Over the years, they’ve built complex and costly risk technology infrastructure that are in many cases no longer fit for purpose due to regulations change, emerging risks such as cyber and a more complex risk environment in general. The use of public cloud capabilities offers an attractive way to address this large legacy technical debt and modernize risk capabilities.

The compute technology needed for risk management is rapidly advancing in sophistication, resulting in a need to upgrade data centers on a timeframe that is quicker than has historically been the case. Regulatory requirements for advanced risk management capabilities such as intra-day risk calculations, more frequent stress testing and increased focus on non-financial and operational risks is introducing new requirements that existing technical platforms cannot easily handle. Finally, the trend to introduce more intra-day risk management is resulting in models being executed at a higher frequency which puts additional load on the data center.

Many of the largest tier one broker dealers are accelerating deployment of public cloud in their infrastructure with risk management as a key focus area. A few public examples include:

- **Goldman Sachs**: At the 2017 AWS re:Invent conference, Managing Director Roy Joseph discussed how the use of virtualized compute is changing Goldman Sachs’s corporate IT environment. Goldman Sachs now has more than 7,000 applications using 200,000 servers and 1.2 million compute cores in a virtualized environment, resulting approximately a 20 percent cost reduction. While Goldman Sachs states that it uses predominantly private cloud at the moment, it is slowly ramping up its use of hybrid and public cloud and risk management is a key area of use.

- **Bank of America**: In 2017, Bank of America chose Microsoft Azure to deliver cloud-based productivity and collaboration tools. The firm ran 33,000 workloads on cloud in 2016, and expect to add 2,000 per month through 2019. It announced in 2016 that is had already reduced its network, storage and server bill by approximately $1.1 billion vs. 2012 costs.

- **UBS**: In mid-2017, UBS announced that it had moved part of its risk management platform to Microsoft Azure, speeding up calculation time by 100 percent and saving 40 percent in infrastructure costs.

- **Mizuho**: In May of 2018, Mizuho Bank announced its plans to develop a market risk management system using a cloud computing environment provided by Amazon Web Services. They believe that cloud computing will allow them to procure system resources necessary for large scale computations that will be required under the Fundamental Review of the Trading Book initiative.

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2 Source: AWS, Network World, FinTech Future, Finextra
3 Fundamental Review of the Trading Book – a global financial regulation introduced by the Basel Committee
4 Source: https://www.mizuhobank.com/company/release/20180530release_eng.html
ADOPTION BY THE BUY-SIDE

Adoption of advanced, cloud-based risk management capability by the buy-side is less advanced than the sell-side due their overall cloud strategies being not as developed. They also tend to be slower adopters of emerging technology than the sell side.

As a benchmark, for large mutual funds the average spend on risk technology is around one basis point of their assets under management and for hedge funds, spend for portfolio risk management goes as high as 20 basis points. Given this spending level, and the opportunities that exist for asset managers to drive similar improvements in sophisticated risk management at a lower cost by leveraging public cloud capabilities, it is not surprising to see investments in this area accelerating by asset managers.

Some notable examples, include:

1. **Blackrock** is currently re-architecting its trademark risk and portfolio management system, Aladdin, for a transition to a cloud-centric architecture, with a specific focus on the use of containers to support burst capacity.6
2. **Vanguard** made the decision in 2015 to pivot from a private cloud strategy to one based on the public cloud.7 Since that time, they have been actively migrating applications onto public cloud infrastructure with a focus of reducing compute loads on the mainframe and reducing compute capacity waste due to needed to plan for unexpected spikes in need.
3. **St. James Place**, a UK based wealth manager articulated a cloud-first strategy in 2015 with plans to move its entire IT infrastructure to the public cloud.8 One area of focus was the migration of several hundreds of petabytes of data from dedicated data centers to a virtual private cloud (VPC) based architecture.
4. **PIMCO** announced a strategic partnership with Beacon Platforms in 2018, to support cloud-based delivery of its quantitative research, proprietary valuation models, and risk analytics to the firm’s 240 portfolio managers globally.9

POWERING THE NEXT GENERATION OF RISK MANAGEMENT

What makes the possibility of managing “risk in the cloud” attractive are the possibilities unlocked by what is essentially access to unlimited computing power. It is this capability that will spark a new generation of risk management. The first movers in this transition will be able to create new competitive advantages that can help reduce losses, generate new revenue streams, and better plan for the future. They will be able to measure and take on risk that others will shy away from.

5 Source: Celent, Oliver Wyman proprietary data and analysis
6 http://rockthecode.io/blog/transitioning-blackrocks-aladdin-cloud-architecture/
7 https://www.cloudtp.com/doppler/maximizing-your-move-to-aws-five-key-lessons-learned-from-vanguard/
Below are four key areas where we see the cloud powering the next generation of risk infrastructure:

SCALABLE AND UNLIMITED COMPUTING POWER (IAAS):

Risk management functions typically consume a vast amount of compute resources for a very short period of time. Historically, analytical models were either reduced in complexity or limited in the data they could consume due to limitations in the amount of compute resources that could be deployed. The use of the public cloud’s highly elastic, pay-for-what-you-use model eliminates these restrictions. The emergence of container services further enhances the abilities to rapidly scale analytical models for risk management.

SOPHISTICATED MANAGED DATA CAPABILITIES (PAAS):

The complexity of standing up a petabyte sized data architecture to transform and store the data needed for risk management was overwhelming for all but the most sophisticated financial services firms. Today you can rent a modern, scalable data environment from any of the major public cloud providers and they will take care all aspects of its management including security and disaster recovery.

DATA AGGREGATION AND VISUALIZATION (FAAS):

Risk management not only requires the calculation of analytics but the interpretation of results. Public cloud providers and their partners are deploying sophisticated data visualization capability in the same pay as you go model as their compute and storage services. These tools are fast to deploy, mobile enabled and allow risk managers to slice and dice data in nearly any way they can dream of.

MACHINE LEARNING IN A BOX (FAAS):

The use of machine learning-based algorithms for risk management is seeing accelerated adoption as financial services firms look to generate valuable business insights based on large and innovative data sets. Each of the major public cloud providers has launched their machine learning training and deployment capabilities, taking the complexity out of deploying this increasingly advancing technology.

But how can all these tools be leveraged to bring value to a risk professional? While our goal is not to write a prescriptive description of how risk on the public cloud will be performed in the future, we wanted to sketch out the basic outline of the path we see many financial institutions following as they deploy next generation risk management capabilities.

- A truly integrated risk data environment: Migration to the cloud will enable an organization to integrate the various disparate data sources and, as a consequence, minimize reconciliation of both underlying data and model output. It’s not unrealistic to imagine a future scenario where manual reconciliation becomes obsolete. Furthermore, unlimited integrated data storage will, over time, allow for the creation of enriched historical data sets which can be draw upon for future model development. In this new world, nothing will need to be deleted or archived.
• A standardized methodology for incorporating new data: Standardized frameworks for data ingestion and processing imposed by public cloud providers can instill greater discipline amongst risk managers in how data is treated and applied. It will become much easier to incorporate new data sources, risk drivers, as well as to introduce new instruments into this new data environment.

• Fully traceable and auditable risk management infrastructure: A clean, structured, and rich data environment can create substantial transparency and auditability. This is a sharp contrast to today as reconciliation is often manual and time consuming. In the future, it will be possible to use data history to do root cause analysis of past decisions and actions. As a practical example for banks that provide prime brokerage services, it’ll be easier to audit and justify margin calls.

• (Near) real-time measurement of risk: the words “batch processing” and “end-of-day” may become obsolete terms even for the most complex portfolios as near real-time full-re-valuations become a very feasible reality. In pockets, where full-revaluation will continue to be time consuming (such as with value adjustment calculations), machine learning-based techniques will be applied to improve accuracy of approximations.

• A nimble development cycle: a more standardized and auditable data environment supported by a modern suite of developer tools will substantially reduce the time to bring new risk models into production. Unlimited computing capacity can make it possible to run, test, and compare multiple models simultaneously. Moreover, by leveraging the container services that are being rolled out by public cloud providers, it will be easier for new risk models to be built, back-tested and shared across an institution.

As these sophisticated tools are made more widely available to risk managers, they will support a more fundamental change in how risk management is performed. We expect to see the following trends accelerate as a result.

• Acceleration of risk model sophistication: Unlimited computing, better data management, and more efficient infrastructure all make public cloud a natural environment for running the next generation of statistical and machine learning based algorithms. These capabilities will expand the boundaries of traditional risk measurement and management generally.

For example, the public cloud could help improve quantification of risk, particularly in asset classes and instruments where full-revaluation continues to be time consuming and challenging, as with certain types of valuation adjustments.

A few concrete examples:

− Portfolio construction can be performed based on forward-looking scenarios, which could create much more variability in terms of trading strategies employed. Currently most industry leading vendors approach portfolio construction through a one period mean-variance optimization, while with access to enough computing capacity generalized dynamic optimization will become mainstream.
- Quasi-live full repricing will become the new industry norm. Today pricing of complex portfolios of non-linear instruments is largely done by Greeks approximation and full portfolio repricing can only be executed in batch mode. However, migration of risk management systems to the public cloud could make quasi-live full repricing accessible to every industry player.

- Rise of risk-as-a-service business models: Except for notable exceptions like Blackrock’s Aladdin platform the existence of established legacy on-premise risk infrastructure has served as an obstacle to adoption of risk-as-a-service models. We see the adoption of public cloud, with its application programming interface-driven and container-based infrastructure and more nimble development cycle, as a likely spark to accelerate the prevalence of such business models. We would not be surprised to see a variety of business models emerge, including the following examples:
  - The proliferation of niche risk-analytics vendors that offer their capabilities on the app stores of the major public cloud providers. These container-based capabilities would be designed to interoperable with the existing cloud-based risk infrastructure deployed within banks and asset managers.
  - Market analytics providers deploying forward-looking scenarios daily or weekly directly into the risk infrastructure of their subscribers.
  - Outsourcing of middle office risk management by the buy-side community to a bank or platform outsourcing firm in which the infrastructure is cloud deployed within the asset managers virtual private cloud.
  - Sale of trading algorithms underpinned by differentiated risk models, deployed within a customer’s cloud-based environment.

- Risk front and center in decision making: Today financial institutions have a disjointed vision of risk. For example, while front office traders care about daily changes in market prices, risk managers look at quarterly horizons while running Comprehensive Capital Analysis and Review (CCAR) stress-testing simulations. This limits the ability to use risk management techniques as a tool to forecast consequences of decisions that impact the whole firm.

However, the power of a public cloud enabled risk infrastructure will allow for the portfolio to be priced at any future time horizon, be it daily, weekly, or yearly. This would enable the same data and analysis to be used not only by traders and risk managers but also by the C-suite. In one version of the future, analysis of risk-adjusted performance could become table stakes in formulating and articulating tactical business decisions as well as strategy. Risk management could become a material input into financial planning and analysis activities.
BUILDING THE BUSINESS CASE FOR CHANGE

While there has been significant interest from banks and asset managers around the cost efficiencies enabled by a transition to the public cloud, we think it is critical for financial services firms to look beyond a simple cost play when it comes to generating advantages in risk infrastructure. The real competitive advantages start to accrue when you use the public cloud to do things that are extremely difficult using traditional on-premises infrastructure.

Of course, the traditional levers of cost savings that the public cloud unlocks are still in play. These include the potential for substantial reduction in hardware costs due to more efficient and elastic uses of compute resources and elimination of huge modernization costs. Material cost reduction can also be achieved by moving to a development-and-operations-based framework to deploy new analytics and risk visualization capabilities, allowing infrastructure support headcount to be reduced up to 50 percent.

Based on our proprietary data, we estimate that an average investment bank can realize savings of between one half and one percent of the total cost base through a lift and shift of risk infrastructure to the cloud. For a bank with $10 billion in annual wholesale banking revenues and a cost income ratio of 60 percent, this would imply up to a $60 million of potential cost savings per annum.

To illustrate this savings potential, consider the following hypothetical scenario:

• The average a global investment bank spends between three percent to five percent of its overall cost base on risk management.
• Of this spend, the spend on risk technology costs including hardware, licenses, and Risk Operations and Technology full-time employees accounts for approximately 30 percent and as such, risk technology represents anywhere between one percent to three percent of the overall cost base.
• Assuming an average 30 percent cost saving achieved through one-to-one migration of existing risk infrastructure to public cloud, an expected realized cost savings would be between 0.5 and one percent of the total cost base.
• For a bank with revenues of $10 billion and a cost income ratio of 60 percent, this would imply up to $60 million of potential cost savings per annum.

While these savings are meaningful and can have substantial impact on wholesale banks’ returns on earnings that are hovering right at the hurdle rate, from the top-of-the-house perspective, a business case for migrating risk infrastructure to the cloud based on purely cost savings may not be entirely convincing, given the need for a potentially challenging transformation. It will be important to consider the additional value created via a next generation risk capability to convert sceptics.
CONCLUSION

In this paper, we have discussed only a vague outline of the future that unlimited computing can unlock in risk management. To begin this journey, risk managers, bankers, traders, portfolio managers, and other key stakeholders would need to think about the ways in which public cloud enabled risk management can become a source of competitive advantage and to lay the framework for not only migrating existing risk infrastructure to cloud, but taking advantage of the opportunities it creates to rethink the operating model for risk.

The financial institutions that embark on the journey of figuring out how access to unlimited compute can be leveraged to create an advanced risk management capability, will realize competitive advantage not only through increased efficiency, but will be able to understand and therefore price risks that competitors will shy away from. This will impact top line revenues in addition to reducing operational costs.
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