EVIDENT AIINNOVATION BANKS

AI innovation in banking. Mapped.

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EVIDENT AI INNOVATION BANKS

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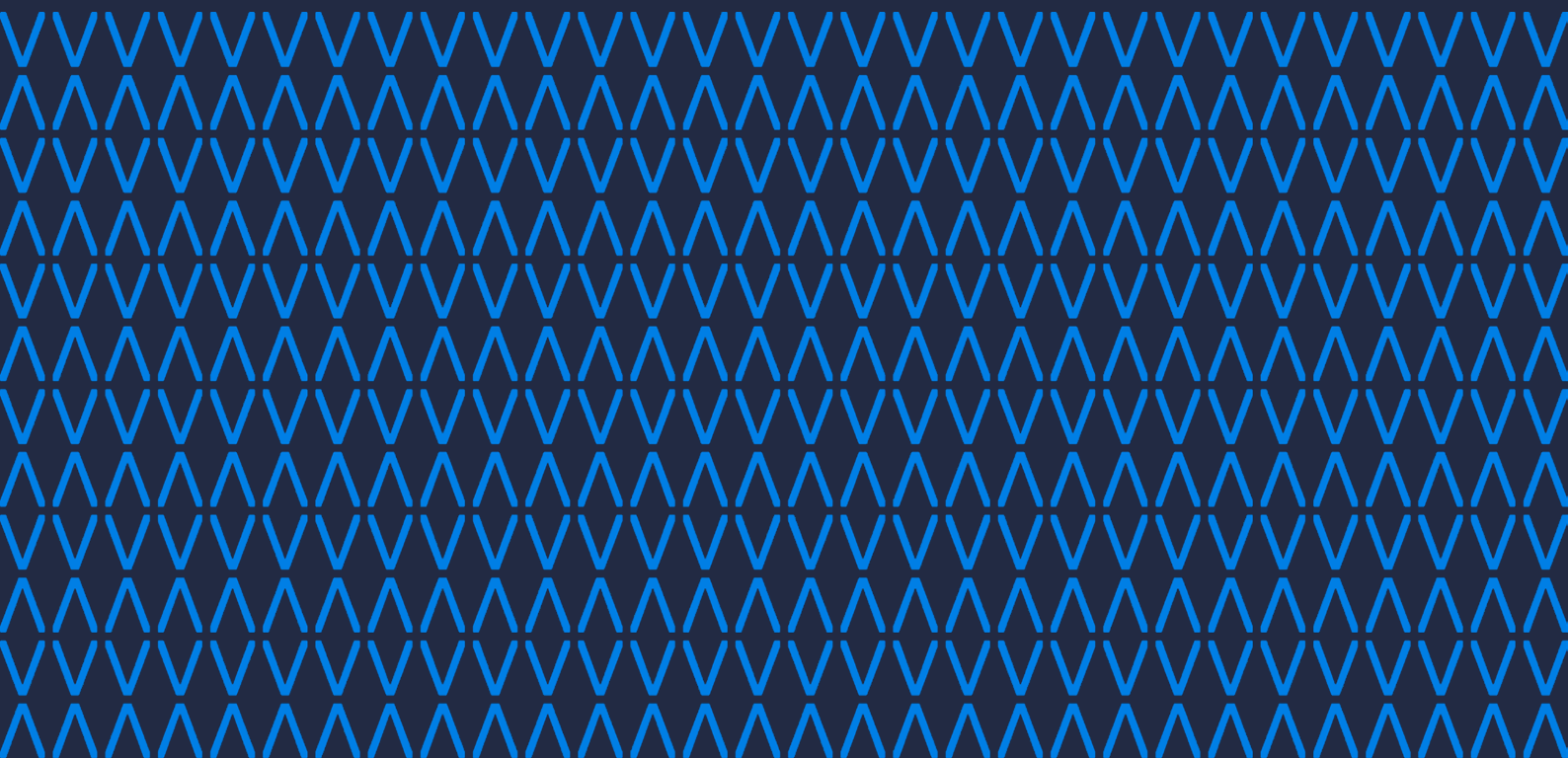

EVIDENT AI INNOVATION BANKS

About Evident

We provide banks with independent data, research and benchmarking to accelerate their AI transformation. Our mission is to help leaders in the banking industry make informed AI-related decisions, investments and strategic choices.

Using proprietary machine learning tools, we extract data from millions of public documents. We combine this data with our unique expertise in banking, AI and benchmarking to publish the Evident AI Index, the leading global measure of AI maturity in the financial industry. The Evident AI Index uses 142 distinct indicators to rank 23 of the largest banks in the world on their AI maturity, and will soon be expanded to cover 50 banks and financial institutions in North America, Europe and Asia.

In addition to our Index, our Insights Reports provide the most in-depth and up-to-date analysis of AI adoption across the banking sector, combining our data with qualitative insights from our expert network to reveal cross-sector trends, map best practice and help financial institutions compare their progress against that of their peers. Our Insights Reports and accompanying webinars are a major reference point for academic researchers, journalists, policymakers and AI thought leaders.

Our members benefit from exclusive access to all our data and insights, as well as access to our flagship annual Evident AI Symposium which brings together CEOs, CIOs and AI leaders from across the financial industry with tech industry executives, policy-makers and AI thought leaders.

Our data, research and products cover five critical pillars of a bank's AI ecosystem:

TALENT	Aquisition	Staffing	Development	Retention
INNOVATION	Research	Patents	Ventures	Ecosystem
LEADERSHIP	Strategy	Operating Model	Executive Positioning	Communications
RESPONSIBLE AI	Principles	People	Publications	Partnerships
OUTCOMES	Use Cases	Return on Investment	Sophistication	Impact

ACKNOWLEDGEMENTS
A sincere thanks goes to Tim Gordon, Partner, Best Practice AI whose input and expertise has been invaluable in the writing of this report.

We're here to promote best-practice and provide unrivalled insights to the industry at large, which is why we actively seek to engage leaders across the banking sector to explore these trends with us in more detail. Do get in touch to find out more about who we are, and how we're creating the definitive independent benchmark for tracking industry-wide AI adoption and readiness.

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Executive Summary
Ten key takeaways

1. Different strategies are emerging when it comes to AI innovation in banking. All banks are thinking about how AI can enable their bank to operate better, faster and more efficiently. But a handful of banks appear to be pursuing cutting-edge AI innovation. They are characterised by:
→ A focus on pure and applied AI research. Scarcity and cost of research talent make this is an expensive strategy that few banks can follow
→ A volume of highly cited AI-related patents. Once again, this is a strategy that not every bank can follow - especially in Europe where patent filing is more restricted
→ A strong ecosystem: participation in the open source community, as well as a wide range of partnerships with universities, accelerators and vendors
→ Strategic investments into early stage companies at the cutting edge of AI - ideally with an internal venture rather than a VC returns focus alone

2. Concentration at the top is clearly emerging. In each area of this report the top five banks have:
→ Published 67% of the AI research
→ Filed 94% of the AI patents
→ Made 51% of the AI investments

FIG 01. RANKINGS OF THE TOP FIVE BANKS ACROSS KEY AI INNOVATION METRICS

NUMBER OF AI RESEARCH PAPERS PUBLISHED (2017-2023)	NUMBER OF AI PATENTS FILED (2017-2021)	NUMBER OF AI INVESTMENTS MADE (2017-2023)	NUMBER OF ACTIVE AI-RELATED GITHUB REPOSITORIES
1. JPMorgan Chase	1. Capital One	1. Wells Fargo	1. Capital One
2. Royal Bank of Canada	2. Bank of America	2. Goldman Sachs	2. JPMorgan Chase
3. TD Bank	3. JPMorgan Chase	3. First Citizens	3. BBVA
4. Capital One	4. Wells Fargo	4. Citigroup	4. ING Groep
5. Wells Fargo	5. TD Bank	5. JPMorgan Chase	5. TD Bank

3. North American banks are accelerating away from their European competitors. They:
→ Published 80% of all AI research in 2022
→ Filed 99% of all the AI-related patents in 2021 (the most recent full year of filings)
→ Made 60% of all AI-related investments in 2022
→ While there are structural reasons for this (e.g. AI patenting is more restricted in Europe), these findings reinforce the message from our previous work on the Evident AI Index and the Evident AI Talent Report published earlier this year

4. The same names consistently appear: JPMorgan Chase, Capital One, Wells Fargo alongside RBC (and in some instances TD Bank) from Canada
→ Combined with their strong showing in our Talent work, we can see leadership positions being taken that will become increasingly hard to overcome
→ The long tail of North American banks will find that competition with the top tier banks is going to get even harder

5. We see comparatively little AI innovation across European banks
→ BNP Paribas typically leads the French banks but is outside the top 10 in almost all categories
→ The UK banks rarely feature amongst the leading banks in any areas (the exception is Barclays' top 10 performance on AI-related ventures)
→ It is possible that a Spanish bank like BBVA could emerge as a European champion, a space that awaits a serious claimant
→ Whilst we only touch on the Rest Of World banks, institutions in APAC currently look to be the only significant potential AI innovation competitors to the North Americans

6. Publication of AI research across the banks and payment providers has grown at a CAGR of 70% from 2017 to 2022
→ JPMorgan Chase leads the field in terms of volume of published AI research papers (nearly 300 papers published since 2017) and team size (more than 120 AI researchers at the bank)
→ We find more than 650 individuals working in AI research positions across the banks - 40% have joined the banks since the start of 2022
→ India is second only to the US in terms of the number of AI researchers, indicating a significant pool of high calibre AI talent in the country
→ Research focuses on a mix of applied and theoretical research, with a focus on deep learning
→ We see a high proportion of researchers in trading relative to published papers, suggesting that this is an area with significant unpublished research

7. Patent registration is a strategy being seriously pursued by only six of our 60 banks, with a 40% CAGR (2017-2021) and more than 1,400 patents filed in 2021 alone
→ Bank of America has historic dominance in this area, but is being challenged by Capital One, which filed 477 patents in 2021 (more than any other bank)
→ The escalating pace of patent filing suggests that this is an area where first-mover advantage, and protective lock-in, is being eagerly sought
→ Nearly 15% of all patents filed by banks are focused on trading, followed closely by payments and compliance

8. Ecosystems are being built with multiple partners
→ Universities provide recruitment, research and accelerator opportunities - and smart banks are broadening their access to global ideation by stepping beyond purely domestic relationships
→ Capital One's engagement with open source is a key part of building its brand and IP - similarly for JPMorgan Chase, BBVA and ING

9. Investment in AI companies is also growing - at 15% CAGR from 2017 to 2022
→ The top five AI investors are all US banks, accounting for almost 50% of all investment deals from 2017 to 2022
→ Wells Fargo is the clear leader in this space, followed by Goldman Sachs and First Citizens (after its acquisition of Silicon Valley Bank)
→ European banks are challenging US dominance: 90% of AI-related investments were made by US banks in 2015; this has since decreased to 60% in 2022
→ French banks lead the European charge - BNP Paribas and Credit Mutuel - followed by Barclays.
→ Not all investments are strategic: around 70% of AI investments look to offer potential assistance to banks in their core mission or functions, while 30% are non-bank related

10. Does Generative AI change the rules of the game?
→ To date, AI innovation has been a top-down game characterised by strong leadership, aggressive focus of resources and highly educated AI specialists
→ Advancements in Generative AI have reinforced this - banks need a centralised AI innovation strategy, with group-wide orchestration and leadership
→ That said, easy access to Generative AI tools like ChatGPT also allows for new levels of bottom-up innovation, creating new working practices and business tooling
→ Those that manage to let their staff test and share their new AI hacks will have cracked possibly the biggest innovation opportunity on offer: how to genuinely become learning organisations.

Executive Summary

Ten things innovation leaders in banks should do now

1		Establish an AI innovation strategy - ideally with a sense of vision for the future and a roadmap against which to prioritise investments.
2		Build an AI research team, covering applied and pure research, and give them a clear route to liaise with business leaders across the bank.
3		Publish their research, and encourage them to submit papers to leading academic AI conferences - there is a real market gap / branding opportunity for "The European AI Bank" to be created.
4		Build a couple of strong AI university relationships supporting pure research. This might perhaps be with one domestic and one globally relevant university (depending on HQ location).
5		Build out a patent strategy - especially if aspiring to operate in the US or globally.
6		Build internal incentives and foster a culture of patenting to boost focus in the AI patents space. Capital One is a good example of this.
7		Think through what the ecosystem looks like and have a proactive investment strategy to improve it.
8		Lean in to strategic investments - and test out acqui-hires as a strategy. There are experienced AI teams who can be acquired in the market.
9		Continuously benchmark the bank's position and progress against the competition.
10		Celebrate and reward even the first minor steps into AI innovation. Gathering momentum is key.

Introduction
Why AI innovation matters to banks

INNOVATION IN BANKING HAS A MIXED REPUTATION

The expansion of banking services through technology such as ATMs and mobile phone apps have provided new tools for customers. They have made life simpler, easier and - occasionally - cheaper. New products have offered additional ways to save, spend and borrow money, all the while driving down friction and cost.

However, some product innovations - in the mortgage market and structuring tools like CDOs, for example - have led prominent financial institutions to ruin and triggered wider societal costs. Today, banks need to balance the urge for growth and the desire for lower costs with the requirements of stringent risk management. Innovation can help with all three - but too much focus on the first two can lead to huge exposure on the third.

AI can be a lynchpin technology for addressing the challenges of growth, cost reduction and risk management. New products can be built more quickly, propositions scaled at lower marginal cost, and poor credit risks measured and monitored at previously unimaginable scale and scope. Opportunity abounds - but so does risk. AI creates new categories of concern like data bias and fairness of automated outcomes. The sheer scale, scope and speed of AI-powered tools pose new risks to these heavily regulated entities: algorithmically-driven "flash crashes" in markets being but a taster of what might be to come.

Getting AI innovation right is key for the banks that wish to prosper in the coming decade. This will require a mixture of building intellectual property internally, but also pulling in the best of external developments. There are multiple resources to mine and levers to pull - from research and patents, to partnerships and the wider academic, industrial and public sector ecosystems in which the banks operate.

This report will consider how banks are driving innovation in AI, how they are thinking about the choices and trade-offs required and what this tells us about the race to AI maturity in the banking sector. We can see that different management teams are making very different choices in the space. Not having a strategy around AI innovation is also a choice. But it's unlikely to be a wise one.

Methodology
How we put this report together

This report is based on an outside-in assessment of publicly available data, supplemented by interviews with AI and innovation leaders from across the banking sector.

As per our previous reports, the focus of this report is 60 major banks and payment players in North America and Europe. This includes:

→ In January 2023 the inaugural Evident Index covered 23 banks. These were the largest North American and European banks defined by Assets Under Management (AUM) larger than $1trn at January 2022.
→ We have expanded our coverage to include another 34 North American and European banks (including American Express, which is classified as a bank by Standard and Poors) ahead of the next update of the Evident AI Index in November 2023. We have already started tracking these banks and include in this report some of the interesting data that we have already surfaced. Since this decision, Credit Suisse and First Republic have been taken over by other banks: UBS and JPMorgan Chase respectively. They will no longer be tracked as independent entities but they are included in our macro data, including geographic coverage.
→ On top of this we include a further three Payment Players as we continue to evolve our Financial Services market coverage. This brings us up to 60 institutions that, between them, employ over 70% of all banking staff in their combined markets.

Meanwhile we have looked at some Asia Pacific banks to improve the mix of comparable companies. These are frequently cited as good practice in the space, and where relevant will be included in this report as reference points.

FIG 02. TABLE OUTLINES THE COMPANIES COVERED IN THIS REPORT, BY HQ REGION

USA	JPMorgan Chase
	Bank of America
	Citigroup Inc.
	Wells Fargo
	Goldman Sachs
	Morgan Stanley
	U.S. Bancorp
	PNC Financial Services
	Truist Financial
	The Bank of New York Mellon
	State Street Corporation
	Charles Schwab
	American Express
	First Republic
	First Citizens
	Mastercard
	PayPal
	Visa
CANADA	Toronto-Dominion Bank
	Royal Bank of Canada
	Bank of Nova Scotia
	Bank of Montreal
	Canadian Imperial Bank of Commerce
UK	Barclays
	HSBC
	Lloyds Banking Group
	NatWest Group
	Nationwide Building Society
	Standard Chartered
FRANCE	BNP Paribas
	Crédit Agricole
	Crédit Mutuel
	Groupe BPCE
	Société Générale
	La Banque Postale
SPAIN	Banco Santander
	Banco Bilbao Vizcaya Argentaria
	Banco de Sabadell
	CaixaBank
GERMANY	Deutsche Bank
	Bayerische Landesbank
	Commerzbank
	Landesbank Baden-Württemberg
NETHERLANDS	ING Group
	ABN AMRO
	Rabobank
SWITZERLAND	UBS
	Raiffeisen Gruppe
ITALY	Intesa Sanpaolo
	UniCredit
NORDICS	DNB ASA
	Danske Bank
	Nordea Bank
	Handelsbanken
	SEB Group
	Swedbank
AUSTRIA	Erste Group
BELGIUM	KBC Bank
AUSTRALIA	Commonwealth Bank of Australia
SINGAPORE	DBS

WHY ARE BANKS INNOVATING IN AI?
Smart bankers know that the organisations they oversee are in a race.

It is a race to transform themselves into data-centric, AI-enabled players ahead of the competition, i.e. before rival incumbents or new players - Fintech startups, Big Tech - get strong enough to threaten them. If they do not win the race, or at least stay competitive, then these banks will likely join the storied list of historic names that no longer exist - at least as independent entities.

From a series of conversations with senior innovation leaders across the banks, there was no question about the strategic importance of AI innovation to both running and changing the bank, and, of course, to ultimately deliver better products and services for customers, continue the quest for operational excellence;, and enhance trust and security.

However, this is not a race that can be won in quarters, or possibly even years. There is no single magic bullet that will deliver transformative change. The traditional approach to signalling change - acquiring another bank - is increasingly challenging. This is for a mixture of reasons: domestic regulators now frown on the banking consolidation that created banks "too big to fail" (until they did) whilst overseas expansion is seen to carry more risk and execution challenge in the current macroeconomic climate. Finally, shareholders are less relaxed about potential management distractions in increasingly competitive markets.

Therefore management needs to focus on the hard work of building value in-house. And that tends to require a digital transformation of their entire organisation.

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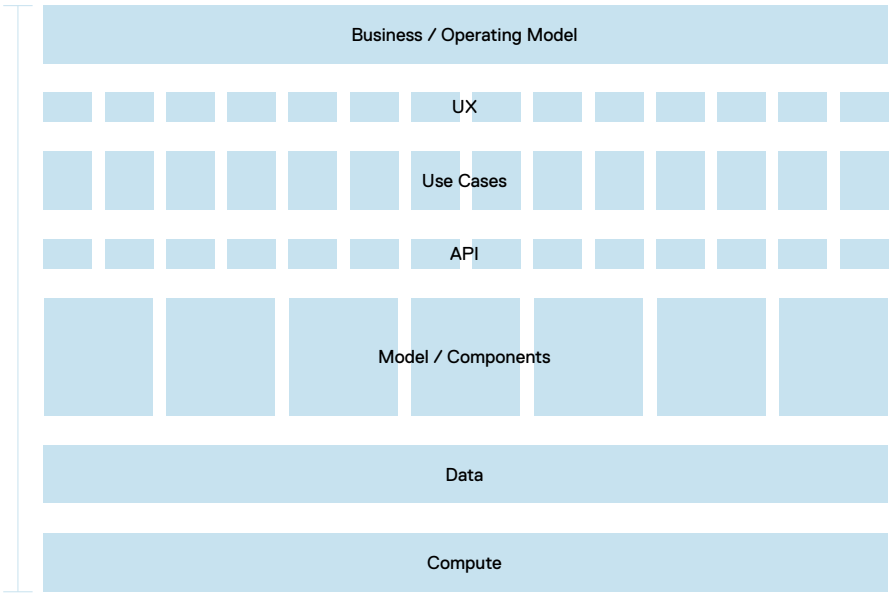
Our focus for the last nine years has been to transform this company into a technology company

Martin Wildberger, EVP Innovation, Royal Bank of Canada

IT is destiny
The aim is to create a new form of banking structure, a simplified and notional version of which can be seen in the following chart. Whilst this describes the tech stack, it is important to understand that the tech stack is increasingly the entire bank. Once defined by the size of their branch networks, banks have moved from the physical world to the digital realm. Key bank functions and attributes - how welcoming they are, how they size up, value and treat their customers, security and profitability - are now defined by their digital offering and infrastructure. IT is destiny.

In the future world banks will have several layers in their tech infrastructure: what will the new architecture look like?

FIG 03. FUTURE ARCHITECTURE OF AI-FIRST BANKS



→ **Compute:** At the foundational layer is compute. The first choice is what will be on the cloud versus on the bank's premises, secondly whether managed by external partners or in-house. Mostly, this will be on the cloud - often with private suppliers such as AWS or Azure. There will be key challenges around access to chips, cost, pricing, partnerships and ESG issues (especially environmental impact) but compute will mostly be bought in from external partners. Security (private bank and national) and risk control will mitigate the cost advantage of partners at the margin. A key question for banks is how closely they align with the BigTech firms offering these services.

→ **Data**: The next layer is data. Historically siloed across multiple products and data systems, the work to create common datasets is a key development in moving towards an AI-friendly architecture. JPMorgan Chase has the Fusion platform, Capital One has worked with Snowflake (an external company in which it has invested), and Morgan Stanley is working with Microsoft to enhance this. This is obviously not simply a question of porting information but also aligning definitions, standards, governance and working through gritty details like unique IDs and data formatting. The win from having fluid, interchangeable data is potentially huge, but the pain of getting there is absolute and real. Banks will buy in data to enrich their content - consumer behaviour or credit-monitoring information, for example - and we can see increased deployment of synthetic data to help build stronger models. There has been a fair amount of internal bank operational innovation to get data structured and managed.

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At Capital One, we say data is the air we breathe

Patrick Barch, Senior Director, Capital One Software (Venture Beat, 2022)

→ **Models:** Every bank will increasingly deploy a modular set of component models. These are the building blocks to allow product teams or use case owners to pull together the ingredients required to bring their ideas, products or processes to market. Examples will include credit scoring or image recognition tools. These will likely be a mixture of in-house development and third-party tools. One of the ways that cloud providers are moving up the value chain, and locking in their customers, is to offer as many of these tools as possible. Banks face a strategic choice as to which tools they will buy in, from whom and under what conditions - and which they will want to build and own internally. It may be that they will modify and localise key models - for example creating their own LLMs trained on internal data. This is a key area for innovation - both internal and external.

→ **APIs:** The role of Application Programming Interfaces (APIs) will be critical to ensuring that the modular design structure can work. Already at the heart of most new external products this approach increasingly drives data architecture inside banks.

→ **Use Cases:** The use case / application layer is where product managers can build and host new products for end-customers. These will pull on different elements from the model layer and access data to ensure that the right product meets the right demand. Whilst many of these applications will be imported from external players, banks need to be very clear about where they will focus on building their own competitive advantage through differentiated products.

→ **UX:** The UX layer will vary across the banking world. That new Generative-AI enabled tools can, for example, build on-the-fly customer-facing web pages will shake this space up. There are multiple security and governance factors for banks to consider but the ability and desire to provide personalised experiences for customers will only escalate. Meanwhile, the building of tools that reach across multiple brands will increase - and we can expect to see banking services pop up across new distribution channels and customer journeys (for example embedding banking functionality more explicitly in consumer buying journeys). This will create new partnerships, business opportunities and risks which AI-friendly banks will be better placed to exploit in a risk-appropriate fashion.

→ **Business and Operating Models:** Business and operating models are beginning to be rethought, including questions on how to ensure that data flows are captured and built back into improving models. This is an area for

considerable innovation, and there is a huge focus within the management consulting industry on positioning themselves as potential thought partners.

→ **Governance:** Governance is a key element for the AI-centric company. Covering everything from data governance and privacy through to AI Ethics and model oversight, the range of new and emerging risks will be a key factor for multiple stakeholders, not least the regulators.

However, this is not where banks currently are. The situation is typically far more complex, products tend to be siloed along the length of their journey and multiple historic acquisitions will simply increase the diversity of their IT architecture.

The challenges for banks are huge. To get there they will need to show innovation against all layers of the AI stack. There is no shortage of innovation opportunities.

FIG 04. EXAMPLE INNOVATION TOOLS FOR BANKS TO DEPLOY TO MEET CHALLENGES ON THEIR AI CHANGE JOURNEY

LAYER	ASPIRATION	TYPICAL CHALLENGE	EXAMPLE INNOVATION OPPORTUNITY
Compute	Cloud-based	Mix of on-prem, legacy and cloud providers	Cloud provider management tools
Data	Single view of the truth	Siloed to product	Synthetic data generation
Models	Modular and reusable	Limited AI tools deployed	LLM deployment
APIs	Consistent	Mixed approaches Limited execution	API management tools
Use Cases	Factory production	Bespoke projects Limited modularity	DevOps tooling
UX	Customer-centric	Product-centric	Customer reaction tracking and scoring
Business / Operating Model	AI-first / re-imagined	Legacy approach(es)	Redefining roles and job descriptions
Governance	Transparent, Explainable, Responsible oversight	Limited	Explainability documentation

HOW ARE BANKS INNOVATING?

In order to innovate, leaders need to be able to imagine a different future, to drive internal debate, refashion priorities and attract more high-calibre recruits at all levels. Ideas will flow from internal and external research teams, open source communities, market activity and start-up interactions - the more the bank can be in the flow of ideas the faster they can begin to deliver on the future that they want to see.

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It is critical that, whether we build or acquire it, the technology we use needs to be easily updatable. Our products need to be plugged into the worldwide innovation ecosystem so that we can adopt emerging advances at a rapid pace.

Prem Natarajan, Chief Scientist & Head of Enterprise Data and AI, Capital One

SIX LEVERS OF AI INNOVATION

In-house research: banks invest in AI research to keep up with the pace of cutting-edge AI advancements. While many banks have some focus on applied AI research, working directly on solving direct business problems, many banks have taken a leaf out of BigTech's book and built extensive "pure" AI research capabilities. We explore this in more detail in the Research chapter.

Patents: these track, or prepare the ground, for business processes and activities.

Ecosystem partnerships: a wide range of partners help banks to source, test and develop new ideas. These include:
→ University partnerships: some purely focus on co-authored research, others involve teaching, PhD fellowships and direct hiring relationships. Universities have historically been at the cutting edge of AI research and development. They offer expertise, fresh perspectives, and highly skilled talent.
→ Technology partnerships: ranging from large, established tech companies that offer AI solutions to startups with innovative propositions (such as FinTech; RegTech; cloud providers) that purport to provide advanced AI tools and services.
→ Consultancy partnerships: firms specialise in providing AI solutions and advice. They can assist with everything from strategy and implementation to training and support.

Open source ecosystem: participation in open source platforms - like GitHub or Kaggle - gives banks access to the combined energies and intellect of the wider community of software and AI developers. Open source approaches can lead to more efficient, and potentially better-debugged, tools.

Strategic investments: banks make strategic investments into firms with novel ideas and AI tools, which can then be scaled and developed for use inside the bank (while delivering ROI for the bank).

Cross-business idea generation: sourcing ideas from across the business is a critical element of AI innovation. Business leaders understand their problems better than anyone else, so encouraging them to identify use cases and collaborate with AI innovation teams is critical (this has been a common theme across the banks when it came to identifying Generative AI use cases in the last six months). Other banks - Capital One, for example - go one step further and actively encourage staff across the business to suggest possible patents (see Patents chapter).

We can think about these levers of AI Innovation along two axes. Firstly, is the IP being generated internally or externally. Secondly, is the IP being generated bottom up (via community or crowd-sourcing) or professionally (typically through top-down allocation of resources or management decisions).

Banks rightly worry about security, process and control, so taking in new ideas, techniques or approaches from outside sources can be a cultural challenge. This is hard enough when it is with professional partners but is even more challenging when the source is the wider community, and we find many banks reluctant to engage with the open source community at all.

FIG 05. THE AI INNOVATION LEVERS

	Professional	Open / community
External	Ecosystem partnerships (consultancies; universities; technology vendors) Strategic investments	Open source engagement
Internal	AI Research (pure and applied) Patent filings	Cross-bank idea generation

AI research can broadly be divided into two categories: "applied" and "pure".

Most banks we cover have some "applied" AI research capability, individuals working on solving the most pressing problems facing the bank and advancing their strategic priorities.

However, in keeping with practices established by Big Tech firms, several banks have also chosen to let their researchers focus on "pure" AI research - working on problems that may not relate to the bank or the banking sector at all - and allow researchers to publish at least some of this research publicly.

For most banks, research is an area that they pursue through university partnerships (see the Ecosystem chapter later) or in the occasional output from an individual researcher. But in the January 2023 Evident AI Index, the focus on research came out as a key differentiator between the leading North American banks and the European banks, whose approach has been more focused on immediate use cases and outcomes.

THREE QUESTIONS WE HEAR REPEATEDLY FROM BANKS:
1: "Why focus on AI research?"
These are not cheap resources - typically highly educated to PhD level. Two arguments for the existence of AI research teams:
→ **To develop innovative models, techniques and tools to put into production.** Often these are designed to be used across multiple business units or functions providing group-level best practice. Researchers will be attracted by the opportunity to access high-quality and mission-critical data and use cases.
→ **To foster an internal culture of innovation and AI excellence.** This means that banks have felt better able to pivot resources and focus as new technology has emerged - most recently the deployment of Large Language Models (or Generative AI).

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We think about the value of pure AI research teams in three ways: 1) the IP, the publications themselves, and the patents are valuable; 2) the brand benefits, and the talent that it helps us to attract to the applied side of the business; 3) the way it increases our speed to react to new innovations. For example, Layer 6 had published several papers on LLMs and GenAI over the last few years that allowed us to react quickly to the most recent developments in these fields using our in-house expertise.

Baiju Devani, Vice President AI/ML, TD Bank

2: "I understand the value of applied AI research, but why focus on pure research?"
It can be hard to quantify the value of these teams if their research is not immediately operationalised within the bank, however, two arguments we commonly hear are:
→ **To be able to react swiftly to new technology:** Generative AI has been a strong reminder that things change quickly in the world of AI. When this happens, having a team that has actively been on top of the latest developments, and driving research in this space, helps banks to react fast. It is important to remember that new technology can come from anywhere - not just banking - so a team focused on AI developments beyond the banking sector is valuable.
→ **To better identify the best and most cutting-edge external vendors:** being able to engage emerging vendors requires a skill set that may be harder to cultivate in inward-facing teams.

3: "Why do banks publish their research?"
While publishing AI research arguably reveals some of its value to peers and competitors, banks also see significant benefits:
→ **To attract the sharpest AI talent**: by publishing pure AI research, banks are able to participate in major academic conferences and participate as "peers" alongside tech companies and other AI players. It demonstrates their talent can work on the combination of applied and pure problems, and helps to attract the leading AI talent to the bank.
→ **To bolster brand positioning**: Given the competitive nature of the AI recruitment market recently, the research teams aim to provide a "halo" effect for wider recruitment as well.

More widely these teams send a symbolic message about the level of senior management buy-in and belief in growing their AI resources and capability. The hope also is that the quality of research will ultimately provide some competitive advantage.

In this chapter we dig deeper into the strategies different banks are taking to AI research, the talent at each bank, and what their research output tells us about their innovation priorities.

RESEARCH VOLUMES

We have used two different approaches to measure the research output of a bank:

Approach 1: "Post start-date analysis" - assesses the total number of AI research papers published by authors only since they started working at the bank. This is the most accurate measure of a bank's real AI research output, but it is limited to authors where it is possible to identify their start date at the bank.

Through this approach we identify 291 researchers that have published AI research since they started at the bank, publishing more than 1,000 AI research papers. There are at least 200 more researchers working at the banks who have not published any research since joining the bank (perhaps unsurprising as many of them joined the bank in 2022).

Approach 2: "All-time analysis" - assesses the total number of AI research papers published by authors affiliated with each bank. This includes any papers published before they joined the bank (limited to papers since 2017) and is a marker of the overarching AI experience-level of the researchers.

With this approach we found a much larger sample - 558 individuals working across the banks that have published over 2700 AI-related research papers since 2017. Given the relatively recent focus on hiring, many of these papers will have been published before authors joined the banks.

Both approaches are valuable, and we use each approach over the course of this chapter.

FIG 06. TABLE SHOWS THE NUMBER OF AI RESEARCHERS, AND AI RESEARCH OUTPUT, ACROSS THE BANKS BY METHOD OF ANALYSIS (2017 TO JUNE 2023)

	NUMBER OF AI RESEARCHERS PUBLISHING AI RESEARCH SINCE 2017	NUMBER OF AI RESEARCH PAPERS PUBLISHED BY AUTHORS SINCE 2017
Approach 1: Post start-date analysis	291*	1039
Approach 2: All-time research analysis	558	2762

*Excludes AI researchers who have not published research since starting at the bank)

BY GEOGRAPHY

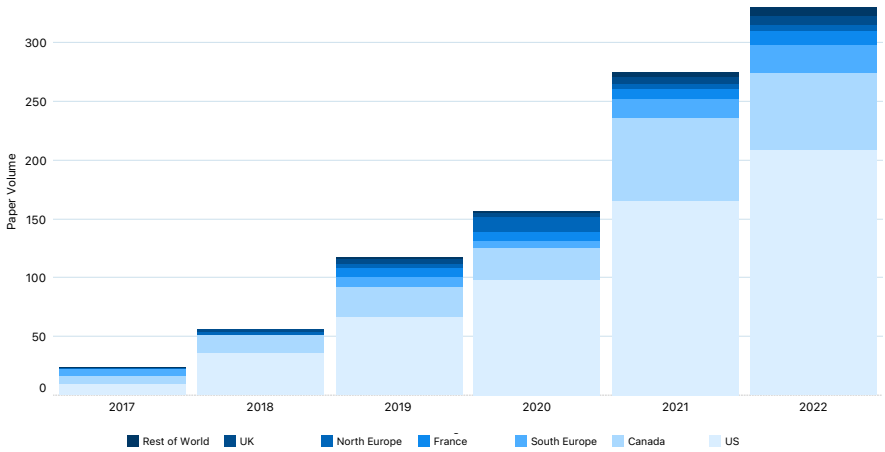
Whichever approach we take, it is clear that the largest banks in North America and Europe have doubled down on the publication of AI research over the last five years.

From 2017 to 2022, the volume of AI research papers published by banks grew on average 70% per year, and the banks collectively published more than 300 AI-related research papers in 2022 (more than 10x the number published just five years ago).

The spread of these papers is highly skewed by region. More than 60% of papers were published by US banks, and 20% by Canadian banks, in 2022. European banks are far weaker - although Southern Europe and France are marginally ahead of banks in Northern Europe and UK - though there are signs of increasing focus, with a 40% increase in European research papers from 2021 to 2022.

However, growth in research output across the banking industry appears to have tailed off slightly from 2021 to 2022 (20% YoY growth), something we will continue to track - and come back to later in the chapter.

FIG 07. NUMBER OF RESEARCH PAPERS PUBLISHED, 2017-22, BY REGION OF BANK HQ



Google Scholar.
Note: excludes AI research papers published by authors before they joined the bank.

We started Borealis AI, our research team at RBC, because we wanted to be the best of the best, the subject matter experts. Many people asked why we would allow these teams to do theoretical research... I've learnt years ago that the more theoretical and applied researchers meet and work together, over time they start aligning their ambitions and work together on issues that matter most to deploying AI across the bank.

Martin Wildberger, EVP, Innovation & Technology, Royal Bank of Canada

BY BANK

We have found evidence of AI research published by 41 out of the 60 banks and payment providers we cover. However, only 11 banks have published at least 10 AI-related research papers since January 2022 - and JPMorgan Chase and Royal Bank of Canada have published more than 50.

North American banks lead the way

North American banks and payment providers occupy 10 out of the top 15 rankings. The top seven publishers are all North American, and the top five players published 68% of all AI research papers published in the last 18 months, a situation that hasn't changed significantly over the last five years, suggesting that leadership positions are hard to build, but sticky.

JPMorgan Chase is a leader in AI research. JPMorgan Chase leads in terms of total number of AI papers published since 2017, a key focus of the bank's AI strategy. They alone have published 27% of all papers published by banks in this time period.

→ **RBC leads the way in Canada.** RBC and TD Bank were both early movers in establishing AI research teams: RBC paved the way for AI research in Canadian banks with the establishment of Borealis AI in 2016, and TD Bank acquired Layer 6 in 2018. Both rank strongly in terms of volume of AI research output, but TD Bank has been overtaken in recent years by Capital One, as well as payment players Visa and Mastercard.

→ **Capital One rounds out the top five**, followed by Mastercard and Wells Fargo, with lower volumes but significant investment in this space

European banks lagging, but some signs of focus

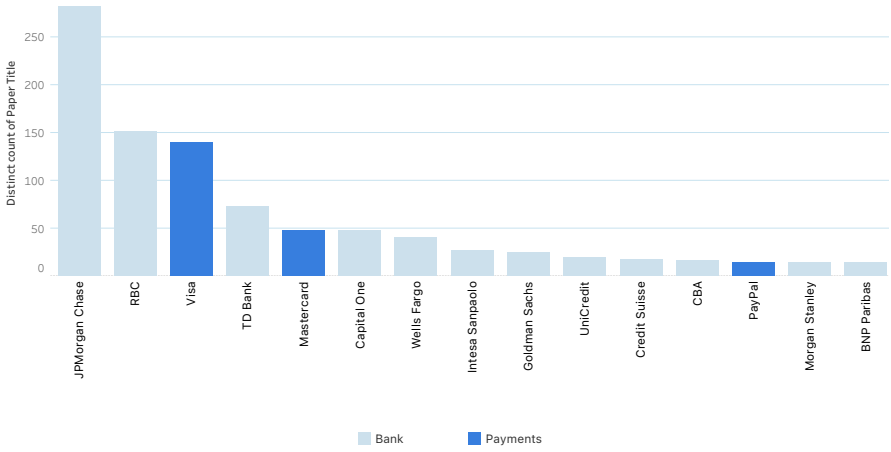
Four European banks feature in the top 15. Intesa Sanpaolo leads the way, publishing more than 27 AI research papers since 2017 (with signs of a burgeoning group of AI researchers at the bank), followed by UniCredit (though largely driven by a single researcher), Credit Suisse, and BNP Paribas. Note: we measure Credit Suisse separately to UBS in this analysis, and will monitor how this evolves during the post-takeover integration process.

There are limited signs of research activity across UK banks: HSBC leads the way (ranking #19th) having published 10 AI Research papers since 2017. The Nordic banks are even more nascent: SEB Group has published one AI research paper, the only Nordic bank to do so.

Commonwealth Bank of Australia also in the mix

Commonwealth Bank of Australia rounds out the top 15, ranking strongly in #12. We will be including four additional APAC players in our coverage between now and November 2023 so will delve deeper into this in due course.

FIG 08. TOTAL NUMBER OF AI RESEARCH PAPERS PUBLISHED PER COMPANY, TOP 15 ONLY (2017-23)

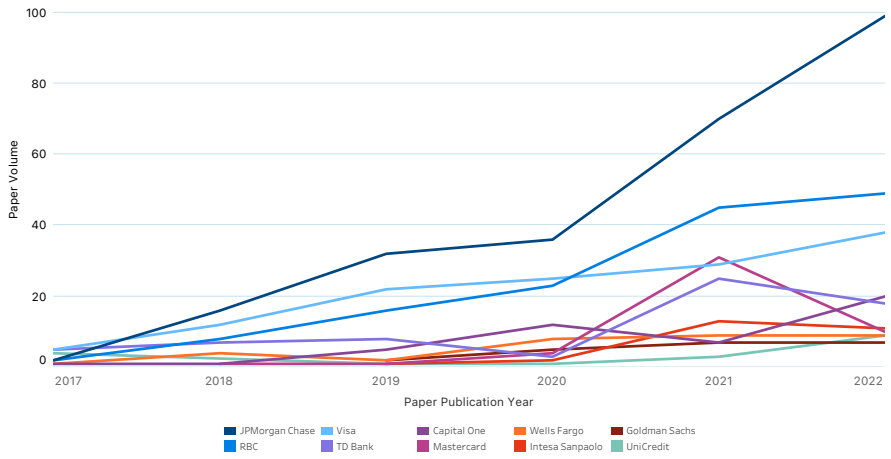


Source: Google Scholar; Evident analysis.
Note: excludes AI research papers published by authors before they joined the company.

Growth is not evenly distributed
Key banks such as JPMorgan Chase, Capital One, certain payment players (Visa and Mastercard) and the Canadians (RBC and TD) have doubled down in this space.

By contrast Bank of America seems to have slowed down and most other banks have not invested significantly in this area.

FIG 09. PAPERS PUBLISHED PER COMPANY PER YEAR, 2017-2022 (TOP 15 COMPANIES ONLY)



CASE STUDY
ANT FINANCIAL, THE CHINESE RESEARCH GIANT

North America is not the only interesting geographic story in the data. In 2022 Ant Financial pipped JPMorgan Chase to the top slot in research volumes, and more than 160 individuals at the bank have published an AI research paper since 2017 (relative to 120 at JPMorgan Chase). This is in line with a broader story of China overtaking the US in terms of overall volume of AI research.

Contrary to some of the sceptical narrative on Chinese AI research, there is limited sign that this quantity is happening at the expense of quality: Ant Financial's lead over JPMorgan Chase is even more substantial in terms of citations. Indeed, on this metric, they are head and shoulders above any of the banks we track in the Index.

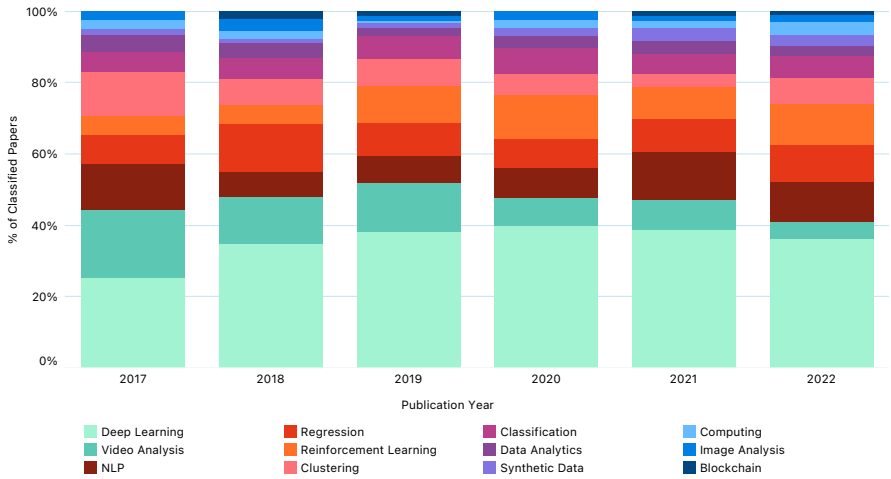
RESEARCH FOCUS
Assessing the research papers published by authors across the bank, it is clear that banks are publishing a mix of both theoretical and applied AI research.

Applied research papers published in 2022 covered a wide range of areas, including:
→ Quantum machine learning applications for fraud detection
→ The implementation of explainable AI in credit decisions
→ The innovative design of chatbots using interactive clustering techniques
→ The potential of recommendation systems to enhance marketing strategies, trading efficiency, and compliance adherence.

A key theme of the more theoretical research is the exploration of decision fairness. In particular, Intesa Sanpaolo has caught attention for its highly cited 2022 paper titled "A clarification of the nuances in the fairness metrics landscape".

Looking at the techniques involved, the majority of research includes "deep learning", a significant amount is still focused on regression, and we see a growing focus on reinforcement learning and synthetic data.

FIG 10. PROPORTION OF AI RESEARCH PAPERS PUBLISHED BY BANKS AND PAYMENT PROVIDERS, BY TECHNIQUE



It is worth considering why banks choose to publish certain research papers. Fraud detection is clearly an issue where better industry performance will help all market players. Therefore publishing is probably an act of self-interest.

By contrast, banks tend to shy away from publishing research in highly competitive areas - especially as such huge financial gains are potentially in play. For example: while trading is regularly cited as a core focus area in the job descriptions for AI research talent, we see very limited focus in research papers published by the banks, indicating a significant amount of this research remains unpublished. We will be exploring this further in the coming months.

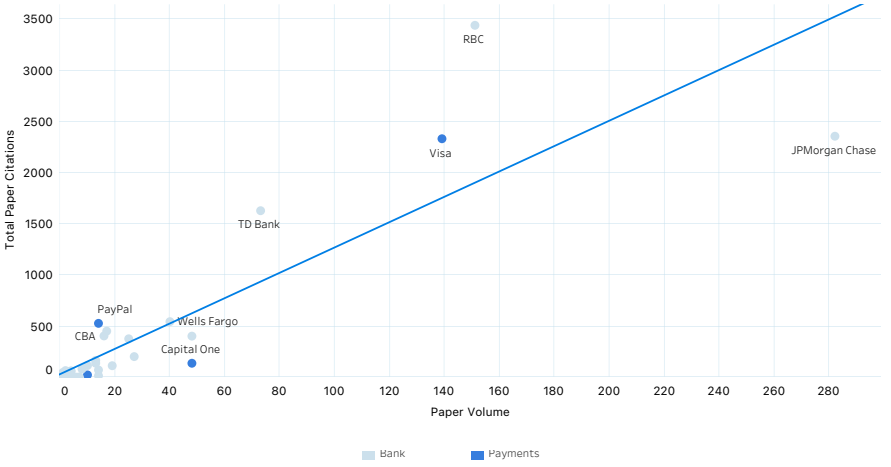
RESEARCH QUALITY

There is inevitably a clear correlation between the number of papers published by a bank and the number of citations gathered as seen in the following chart. Since North American banks dominate in terms of research volume, they also lead the way in terms of total citations - with RBC ranking #1 overall on citations.

There are factors that might explain lower citation numbers at some banks. For example, the more domain-focused the research paper (e.g. in fraud detection at ATMs for example) the less likely it may end up being cited (whilst important, the use case has only a limited potential domain of practitioners). And the more recently published papers may have less time to gather citations.

However, when including the significant volume of AI research published by researchers before they started working at the banks, JPMorgan Chase takes a commanding lead. This suggests JPMorgan Chase has hired experienced AI research talent who have authored a large number of highly cited AI papers before joining the bank.

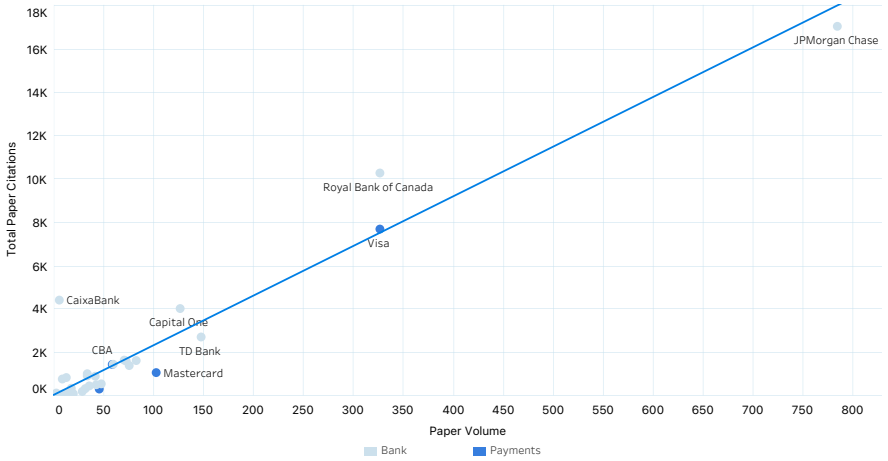
FIG 11. COMPARISON OF AI RESEARCH VOLUME VERSUS CITATIONS, OF AI RESEARCH PUBLISHED BY THE BANK (2017-23)



Note: excludes AI research papers published prior to author's start date at the bank.
Source: Google Scholar

There are other interesting outliers in this field. For example, a single paper on AI Ethics, published by an AI researcher before joining Caixabank, was so highly cited that it ranks as the 4th highest bank in terms of overall paper citations published by our AI research talent. The evidence suggests that AI Ethics papers tend to get cited more widely - clearly the wider the resonance of a topic the more cited it will be.

FIG 12. COMPARISON OF AI RESEARCH VOLUME VERSUS CITATIONS, OF AI RESEARCH PUBLISHED BY THE BANK'S RESEARCHER (2017-2023)



Source: Google Scholar
Note: includes AI research papers published by authors before they joined the company.

RESEARCH TALENT

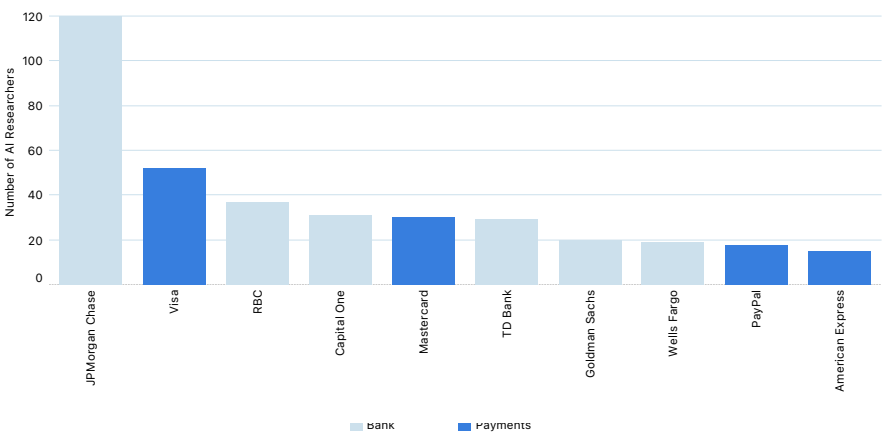
Driving these results are the individuals who write the papers, a group Evident follows closely.

Triangulating between various data sources, we find nearly 660 individuals working in AI research across the 60 banks and payment providers we cover:
→ 558 researchers have published some AI research since 2017. They work at 53 out of the 60 companies we cover (no researchers were found at seven companies).
→ We find another 100 individuals with specific "AI Research" role titles across the banks who have not actively authored AI research on Google Scholar since 2017 - indicating that a lot of research work goes unpublished (this is not a definitive read-out as not everyone who publishes reveals their bank affiliation on Google Scholar).

Banks employ very different numbers of staff in this space (which helps explain the great differences in output of AI research). Only 16 banks employ at least 10 staff who have published research. Only one - JP Morgan Chase - employs more than 100. The next largest employers of AI research talent are Visa, RBC, Capital One and TD Bank.

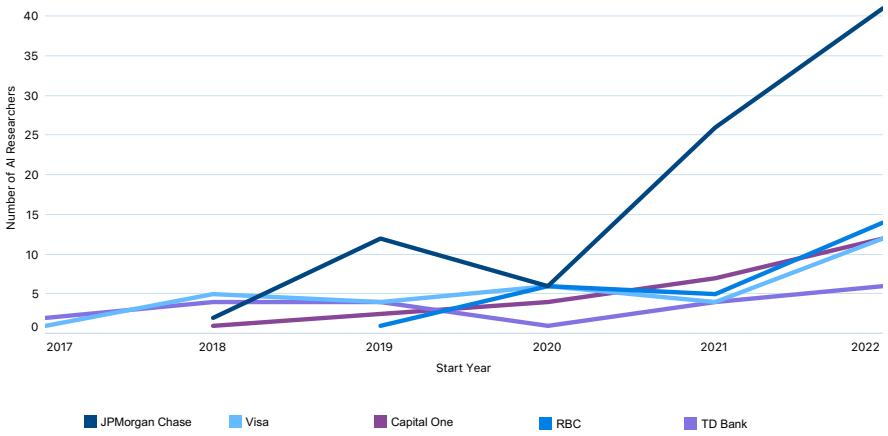
NB: we have found more than 160 authors of AI research at Ant Financial, but we have excluded this from this analysis due to the challenge with sourcing comparable online profiles.

FIG 13. NUMBER OF AUTHORS OF AI RESEARCH, BY COMPANY



Note: includes authors that have published at least one AI research paper from 2017 to June 2023.
Source: Google Scholar, Evident analysis

FIG 14. NUMBER OF AUTHORS OF AI RESEARCH PAPERS, BY START DATE (2017-2022)



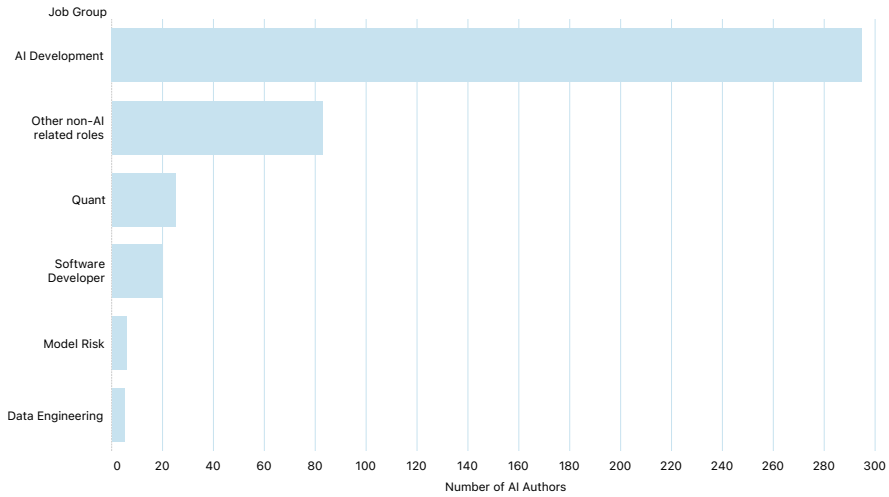
Source: Evident analysis

The leading AI research players have been doubling down on hiring research talent over time. JPMorgan Chase hired at least 40 authors of AI research in 2022 alone (25 in 2021) compared to just over 10 at RBC, Capital One and Visa.

However, definitions of "AI Research talent" vary widely across the sector. As well as differences in the volume of talent across the banks, there is also significant variation in *who* publishes this research.

AI research is published by a wide range of individuals across the banks. 70% of authors work in AI Development roles. The rest work in a broad range of roles across the banks, including Quants, Software Developers, Model Risk experts and Data Engineers, and a whole range of other non-AI-specific roles. Digging deeper, the specific individuals vary significantly by bank:

FIG 15. BREAKDOWN OF AUTHORS OF AI RESEARCH PAPERS, BY ROLE GROUP



Source: Evident analysis
Note: analysis based on a sample of researchers where role titles are available.

→ 25% of all authors work in "AI Research" positions. 25 out of the 53 companies that publish AI research have these roles.
→ More than 100 Data Scientists have authored AI research. As we noted in the Evident AI Talent Report, there is significant variation in the experience-level of Data Scientists hired across the banks - with some job descriptions focusing on Microsoft Word and Excel capabilities. This group is clearly an advanced group.
→ 44 authors have AI Scientist role titles
→ 15 authors are ML Engineers

This lack of standardisation in roles reflects the varied approaches banks are taking to building these teams.

How banks deploy AI researchers
Although there is a lack of consensus on best practices, we identify several models that outline effective strategies for recruiting, managing, and deploying researchers in this field.

MODEL 1: DESIGNATED CENTRES OF AI RESEARCH CAPABILITY.
North American banks often have a significant number of AI researchers, and are strategically looking to emulate BigTech by building cutting-edge research teams.

The model set by companies like DeepMind (Google subsidiary) has been to offer a university-like approach to publishing papers combined with access to deep data and strong compute - to attract the highest quality AI talent. And, of course, corporate-level remuneration.

Example: DeepMind
DeepMind's Research Scientists focus on real "blue sky" research, with the end goal of solving and building Artificial General Intelligence, rather than working directly on Google's business problems.

The role

Research Scientists at Google DeepMind lead our efforts in developing novel algorithmic architecture towards the end goal of solving and building Artificial General Intelligence.

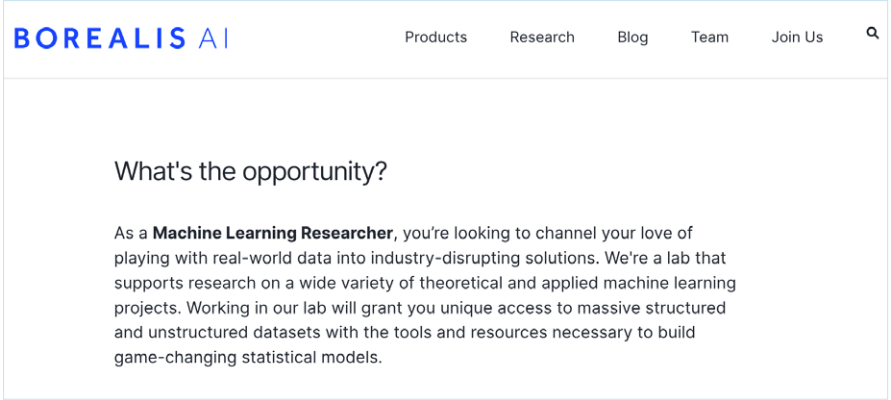
Having pioneered research in the world's leading academic and industrial labs in PhDs, post-docs or professorships, Research Scientists join Google DeepMind to work collaboratively within and across Research fields. They develop solutions to fundamental questions in machine learning, computational neuroscience and AI.

While banks have developed a similar model of centralised AI research teams, even the "purest" AI teams at the banks are somewhat tied to delivering real-world applications.

Capital One's Applied ML Research team sits within the bank's Centre for Machine Learning. This is predominantly focused on applied - rather than pure - research, published by ML Engineers within the team. These individuals are tasked with not only design and research remits, but they also appear to be involved in deploying and building the applications - something that appears to be fairly unique to the bank. This may be due to the smaller size of Capital One, where team members have to wear many hats.

Example job description: Sr Manager, ML Engineer: "Design, build, and/or deliver ML models and components that solve real-world business problems, while working in collaboration with the Product and Data Science teams."

Royal Bank of Canada has an even more clearly defined research unit - Borealis AI. This is run as a distinct business unit, with its own teams for marketing and business engagement. The Machine Learning Researchers in this team focus on "theoretical" and "applied" research.



JPMorgan Chase has by far the largest AI Research team, and appears to focus more on "theoretical" research than the other banks. Job descriptions emphasise advancing state-of-the-art AI, working with universities and presenting their research in major venues. However, it is always tied back to solving real business problems. Note, unlike at Capital One, there is a separate Applied AI and ML team that takes on the task of building and developing the tools for the bank.

Other banks and payment providers with a similar centralised approach include:
→ American Express has a high number of AI Researchers in their AI Lab
→ Morgan Stanley has a Machine Learning Research team (though smaller than peers)
→ TD Bank has Machine Learning Scientists working in their Layer 6 hub
→ BBVA's AI Factory looks to be building a strong team focused on replicable tools that are shared more widely under their Mercury programme

MODEL 2: DECENTRALISED TEAMS WITH UNIFIED RESEARCH FOCUS

Commonwealth Bank of Australia has built research-strong teams, but has explicitly avoided a separate unit dedicated to research. Most of the bank's AI research is published by Data Scientists working within its AI Lab, where staff members are actively encouraged to publish research.

MODEL 3: LET INDIVIDUALS PUBLISH

Not so much a strategy as a state of being. This may be the result of individual arrangements or simply a free-ranging corporate policy. We note that this approach tends to equate to (considerably) lower volumes of research being published.

WHERE IS AI RESEARCH TALENT BASED?

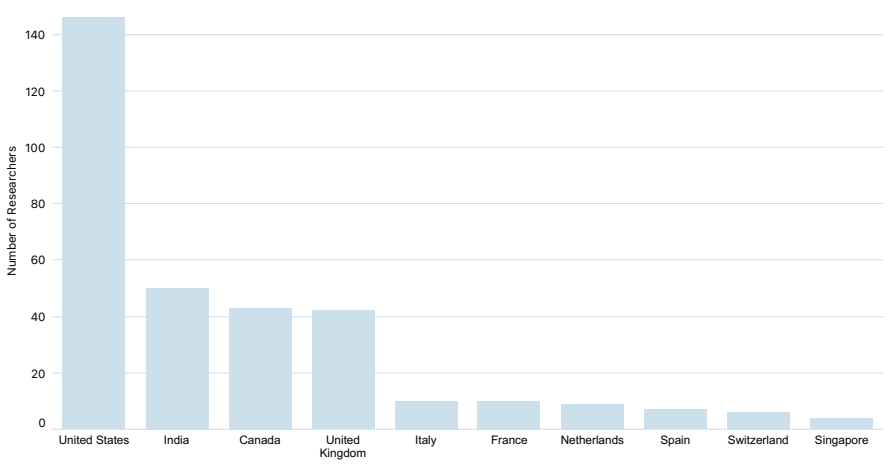
India emerging as an AI research powerhouse, second only to the US

AI research talent is concentrated in four markets: the United States, India, Canada and the UK.

As we noted in the Evident AI Talent report (published in June 2023), India is emerging as a centre of AI talent in banking. While India has typically been perceived as a location for offshoring of lower-level AI or technology positions, our data suggested that India is emerging as a cutting-edge AI research powerhouse, with more talent located there than Canada or the UK.

It is also interesting to note that, while the UK is a source of AI research talent, the majority of this talent works for banks from other regions (primarily the US).

FIG 16. NUMBER OF BANK AI RESEARCHERS BY COUNTRY



India is extremely important to us from our business and talent standpoint....It is not just from the cost perspective, India has phenomenally interesting demographics... it has wonderful universities and higher learning institutions, a wide variety of skill sets and that we can only get in the kind of quantity we need in very few places"

Sara Wechter, Head of Human Resources, Citi (The Economic Times of India, July 2023)

CASE STUDY: CITI DOUBLING DOWN AI RESEARCH EFFORTS IN INDIA

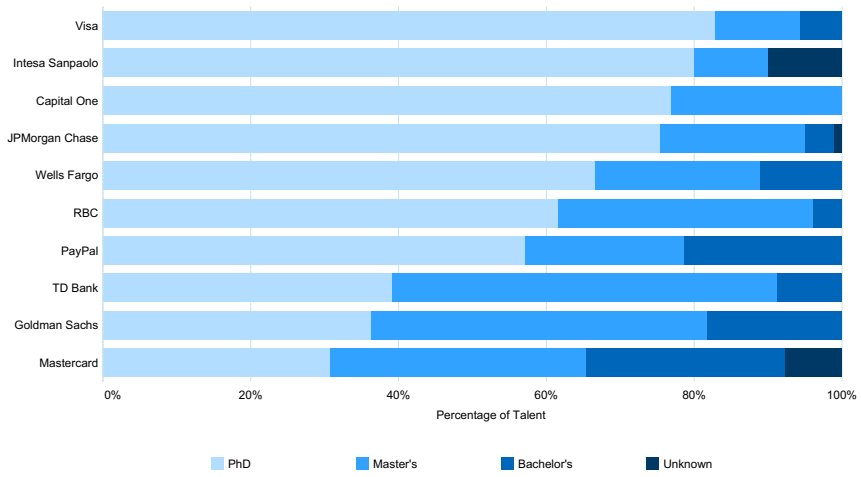
Citi recently announced the bank is hiring 5,000 people in the next 2 years in India, with AI a key focus area alongside tech and engineering. Their Bengaluru unit is the bank's largest analytics centre globally.

Citi Steps Up Hiring in India to Power Global Capability Centres

CSC to onboard at least 5,000 people in 2 years across tech, engg, AI, risk, etc

What sort of people work in these teams?
Individuals in these teams tend to be highly educated. Many worked in University research before moving to the banks, and 67% of AI researchers across the banks and payment providers are educated to PhD level.
It is also interesting to see where this talent leaves to when it leaves the banks. Out of a sample of 65 authors that have left the banks, only five moved to another bank within the sector. The majority moved to tech companies (including Google, Amazon, DeepMind, LinkedIn, NVIDIA, Meta, Palantir), university positions, or investment management companies like Vanguard or Citadel. This makes a significant contrast to the wider AI-related talent pool where we see much higher cross-bank talent flows.

FIG 17. BREAKDOWN OF AI RESEARCH TALENT BY EDUCATION LEVEL AND BANK (TOP 10 BANKS BY RESEARCHER VOLUME)



LOOKING AHEAD: IS THE IMPORTANCE OF PUBLIC RESEARCH SHIFTING?
The publishing of research has been led by practices in the Tech sector. The race to recruit the relatively scarce academic minds who could drive AI forward led to widespread acceptance of the expectation that senior figures would publish papers. The premise was that staff could remain active in the relatively public debate that powered the industry.

This deal may be in the process of changing.

The industry has moved on from power sitting in the hands of individuals to the power of capital. OpenAI's impressive break-throughs have been powered by the application of spiralling volumes of data and compute processing power. This still requires very smart researchers - but also, literally, billions of dollars. Competition has changed the nature of the publishing choice - it is striking that OpenAI has been highly secretive about the training data and approach it took to GPT 4, its latest AI model.

Google appears to be going in a similar direction - even as Meta moves to open source the LLaMA family of tools - as are Mozilla and Hugging Face.

The point is not that everything is ceasing to be open source but rather that this has now become a competitive business decision rather than a matter of course. The presumption of openness has flipped.

This is because AI has become a key competitive differentiator across companies. Whereas the AI research community used to look to each other as a friendly group they may now increasingly find themselves being separated by the rising walls of corporate competition. The number of people involved has exploded - every new analysis of the scale of talent deployed shows that the numbers are growing quickly (see our recently published Evident AI Talent Report). Will this drive a different set of incentives? This also begins to shift the dynamic around recruitment - which is often cited as a key reason to encourage publishing.

It feels too early to ring the death knell for public research, but it may be indicative of future trends that we saw a slight slowdown in the number of papers published between 2021 and 2022, relative to previous years.

Meanwhile, patents are clearly an area that suits the new competitive age.

WHY DO BANKS REGISTER PATENTS?
Unlike the publishing of research, which is meant to open up new intellectual territory, patents exist to create walls around it.

Banks register patents for multiple reasons:
→ **Protection of Intellectual Property (IP)**: When banks develop unique AI processes or methods, they want to protect their inventions from being used without permission.
→ **Competitive advantage**: Patents allow banks to maintain a competitive advantage over their peers. When a bank patents a new AI solution, it prevents other institutions from using the same technology, potentially allowing the bank to stand out in the market.
→ **Monetisation**: Banks can licence their IP to other companies or institutions. Potentially this offers a new stream of (often high margin) income.
→ **Encouraging innovation**: Patent protection incentivises banks to invest more in AI research and development. This can lead to the development of more innovative and efficient banking solutions.
→ **Enhancing reputation**: Owning patents can boost a bank's reputation in the industry. It signals to customers, investors, and other stakeholders that the bank is at the forefront of technological innovation in its field.
→ **Strategic partnerships and acquisitions**: Patents can be valuable assets in mergers and acquisitions or strategic partnership negotiations.
→ **Legal leverage**: In the event of a dispute or litigation, having a strong patent portfolio can provide legal leverage. It can also serve as a defence mechanism against patent trolls.

However, there are trade-offs to filing patents. It is, of course, a costly and lengthy process, and even further costs are involved in defending a patent once it has been granted. Additionally, by patenting technologies, banks risk opening up their approaches to the sector, leading other banks to attempt to reverse engineer them.

Furthermore, not everything can be patented, even if banks wanted to. In the world of AI, here are some general rules:

What can be patented
→ **New algorithms or methods**: If a bank develops a new AI algorithm or method to predict credit risk, for example, it could potentially patent that.
→ **Unique systems or processes**: This might include a specific way of using AI to process transactions or to detect fraudulent activity. If innovative, and it delivers a new (and useful) process, it could be eligible for a patent.

What cannot be patented
→ **Abstract ideas**: You can't patent an abstract idea, and many so-called AI innovations risk falling into this category. For example "using AI to detect fraud" would be too general.
→ **Mathematical formulas**: AI relies heavily on mathematical formulas, but these can't be patented.
→ **Algorithms in isolation**: Algorithms are considered part of the abstract idea category and mathematical formulas. You can patent the specific use of an algorithm, as part of a system or method, but not the algorithm itself.

Note that the scope for what can be patented is subject to local law and different cultural approaches to granting patents. As we shall see the US and Canadian authorities are far more relaxed about granting patents than EU or UK authorities. This will make some cross-border comparisons difficult.

It is worth noting that one upside of having researchers working on broad fields of research is that in casting their nets widely they may come across AI algorithms from different industries or use cases that can be brought back to finance - and potentially patented for specific use in the sector.

Banks can end up owning patents for reasons other than internal research. They are assets that can be traded, directly, or used by client companies to stand surety for loans - especially in asset-light, service or IP-led sectors.

Clearly having the patents associated with a bank for these purposes does not confer ownership. However, not all corporate journeys end happily and, in the event of bankruptcies or loan default, banks can also end up owning patents as assets.

However, at this stage, all of the AI patents that we have tracked at banks were created at, and remain in the hands of, the original registering bank. Whether this will change as the industry matures is something we will be tracking closely.

Banks will be watching out for legal action in this space. So-called "patent trolls" are liable to try and find ways to tie rich institutions like banks up in litigation - something which may emerge as an issue as the volume of AI patents increases. Banks will adopt various strategies - including alliances between themselves and increased patent filing - to ward off this threat.

These factors drive banks' varying strategies in the patent space. For example, some might focus on protecting their core area of business whilst others may have a more expansive approach to colonising potentially promising tracts of IP territory with the hope of monetising or negotiating future advantage. Those without a strategy in this space will likely find themselves increasingly hedged in.

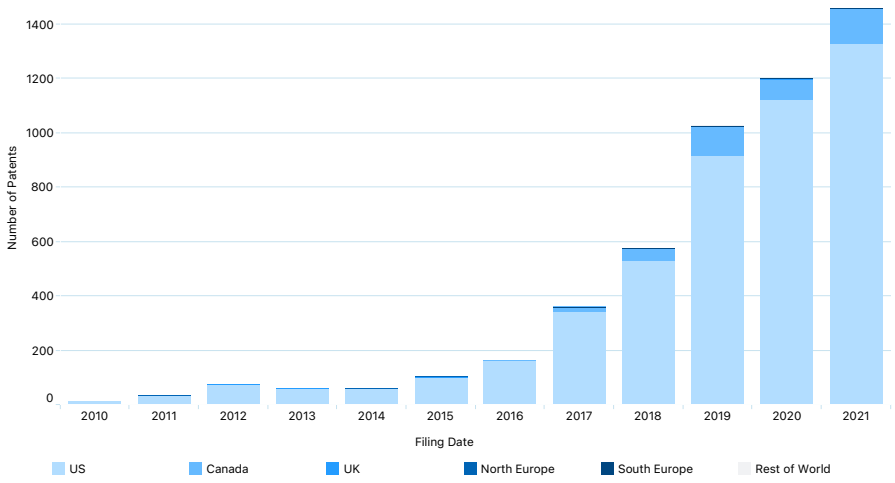
PATENT VOLUMES

As of June 2023, the 60 banks and payment providers own more than 5,600 AI-related patents, all filed between 2010 and December 2021. There is about an 18 month delay between patents being filed and them being made public so we only include patents filed up to December 2021 in this analysis. However, we continue to track patent filing on a monthly basis.

Note: throughout this analysis we have focused on unique "patent families", rather than the individual number of patents filed across jurisdictions - i.e. if the same patent has been filed in four different jurisdictions, we count this as one unique patent (not four).

The number of AI patents filed has grown rapidly, with a CAGR of 40% from 2017 to 2021, and more than 1,400 patents filed in 2021 alone. The vast majority of these patents have been registered in the US, with others in Canada and a very small number in Europe or other markets.

FIG 18. NUMBER OF AI PATENTS FILED BY YEAR, BY REGION OF COMPANY HQ



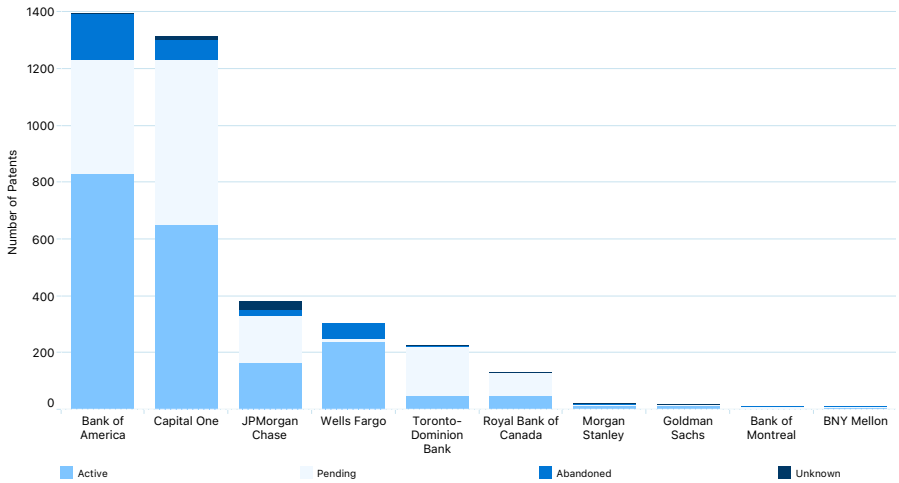
Note: Includes 60 banks and payment providers.

The field is dominated by North American banks

US banks own over 90% of the patents tracked, Canadians 9% and Europeans under 1%. This is largely driven by a small number of banks taking this (very) seriously.

The top five banks have 94% of the registered patents, with Bank of America and Capital One together owning more than 70% of all patents filed since 2010.

FIG 19. NUMBER OF AI PATENTS FILED BY BANK, 2010-2021 (TOP 10 ONLY)



While it is important to note that registering patents is a strategy that is more easily executed by certain market players compared to others (in some jurisdictions it is easier than others) the differences between banks is striking.

Bank of America has 50 times the total number of AI patents filed by all European banks
Bank of America leads in terms of absolute number of patents with 1,396 patents tracked, closely followed by Capital One with 1,315.

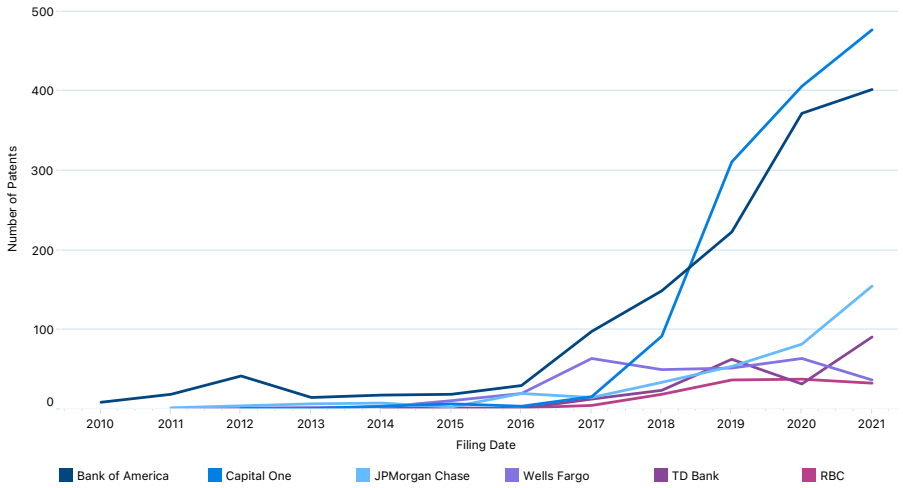
However the status mix is different. 44% of Capital One patents are pending, a factor of more recent patent filings, compared to 25% at Bank of America. At the other end of the lifecycle 11% of Bank of America's patents have been abandoned (the patent was filed, but the bank didn't finish the application) compared to 4% at Capital One.

Capital One is overtaking
Capital One is in the process of overtaking Bank of America in terms of AI-related patents. Since 2019 it has consistently filed more patents, with Bank of America only leading overall due to its legacy position.

Payment providers are also active in this space. PayPal is leading the way, followed by Visa and Mastercard. They would all feature in the top 10 companies if compared against the banks.

> Innovation happens everyday at Capital One. The company has built a simple, accessible program that encourages and motivates associates in all roles across the enterprise to showcase their creativity and become inventors. To some, the patent process can feel mysterious or even intimidating. With our OnePatents program, we want to break down those barriers and make it easy and welcoming for all associates to bring their ideas forward and work with our team
>
> *Ariana Woods, Head of Intellectual Property, Capital One (CapitalOne.com)*

FIG 20. NUMBER OF AI-RELATED PATENTS FILED BY YEAR, BY BANK (2010-2021)

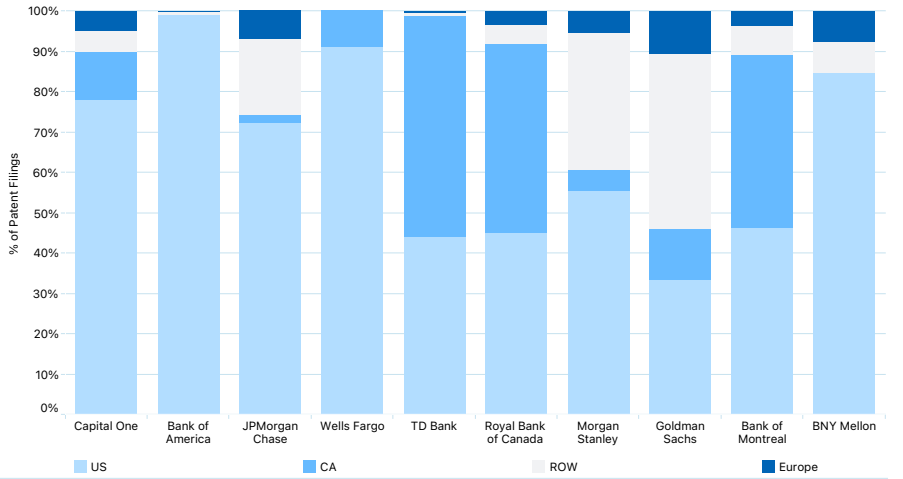


→ JPMorgan Chase ranks 3rd (380 patents filed since 2010), and has steadily increased focus in this space since 2020.
→ TD bank is in 4th place for 2021 filings (227 total patents).
→ Wells Fargo has fallen to 5th place in terms of patents registered in 2021 (the last year we track as it takes 18 months for them to become public), with a decrease in patent filings in 2021 vs 2020.
Beyond the top five, RBC has 134 patents, the next two banks are Morgan Stanley and Goldman Sachs with 22 and 20 patents respectively.

EUROPEAN BANKS ARE NOT IN THE AI PATENT RACE

The lack of patent filing amongst European banks is not a signal that these institutions are asleep at the wheel. European authorities, including the UK, take a more restrictive view on what can be patented than their US or Canadian equivalents. We can see from the leading North American banks that whilst there is multi-jurisdictional work, much of the focus is in the US (even the leading Canadian bank for AI patents - TD Bank - filed nearly as many patents in the US as in its domestic market).

FIG 21. PROPORTION OF TOTAL PATENTS FILED BY BANK, BY JURISDICTION (2010-2021)



Note: Analysis only includes granted and active patents

By comparison, a glance at where UK and Northern European banks are filing patents illustrates a very different story. Not only are there far fewer patents, but they are being registered predominantly with non-domestic authorities.
→ HSBC has filed patents with seven offices worldwide, but does not have a single AI patent registered in the UK. Barclays has filed one AI patent in the UK - compared to three filed in the US.
→ However, it is probably wrong to assume that this is purely a matter of regulatory authorities - JP Morgan Chase has two patents registered in the UK (more than all the UK banks we have data on) even though it is clearly not their primary market of focus.

COMPARISON WITH WIDER PATENT DATA

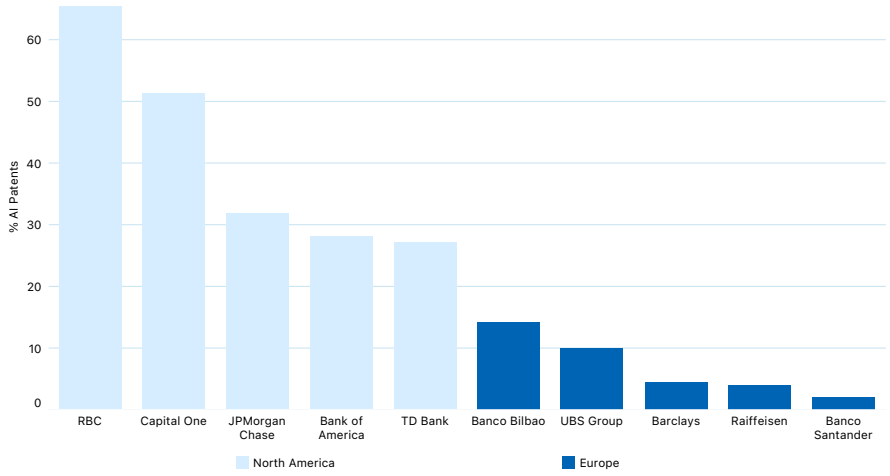
When assessing the relative performance of European banks against their North American competitors the very different approaches of their domestic patent authorities must be considered.

European banks on the whole file fewer patents than their North American peers. But European banks also have a significantly lower proportion of AI-related patents than their peers too.

More than 60% of RBC's total number of patents are AI-related. More than 50% at Capital One. At European banks this is significantly lower: around 15% of BBVA's patents are related to AI, and that is the highest of all European banks.

This strongly suggests that it is not simply the patent regime that can be blamed for the European underperformance. Rather, it is in line with the deep differences in the volume of talent and management focus applied to AI research.

FIG 22. PROPORTION OF ALL PATENTS FILED 2010-2021 THAT ARE AI-RELATED



PROCESS QUALITY: TIME TAKEN TO REGISTER PATENTS

One reason why Capital One is pulling ahead might just be that they appear to have worked out how to manage the patent application process.

→ Their median application timing from filing to grant is 645 days (under two years)

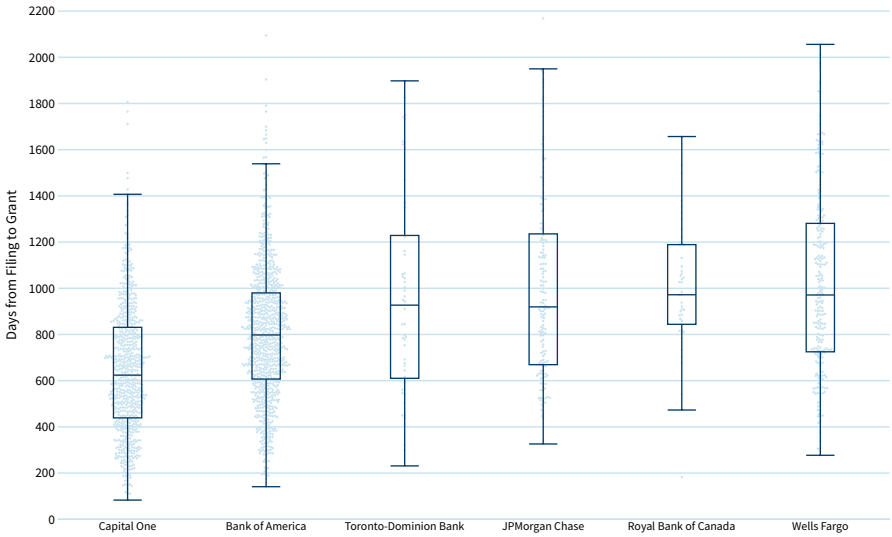
→ Bank of America's median is 814.5 days (roughly two and a quarter years). This is also an outlier as a bank like JP Morgan Chase took 964.5 days (2.64 years) and Mastercard 1048 days (nearly 2.9 years).

→ By contrast Barclays (with far fewer patents) has a median timing of 1654 days (4.5 years). Americans are not always the fastest: Citigroup has the outlier at 1808.5 days (very nearly 5 years).

→ It may be that running a process at scale makes it easier to deliver efficiently, especially as it is clearly a strategic priority for Capital One - and Bank of America.

→ The anecdotal evidence is that important patents get more management focus to speed their processing. However, the data, limited at best, does suggest that important patents can actually take longer (which would make sense in the context of them playing in contested areas of IP).

FIG 23. TIME FROM PATENT FILING TO GRANT (TOP 6 BANKS)



PATENT FOCUS

What patents tell us about bank priorities and strategy

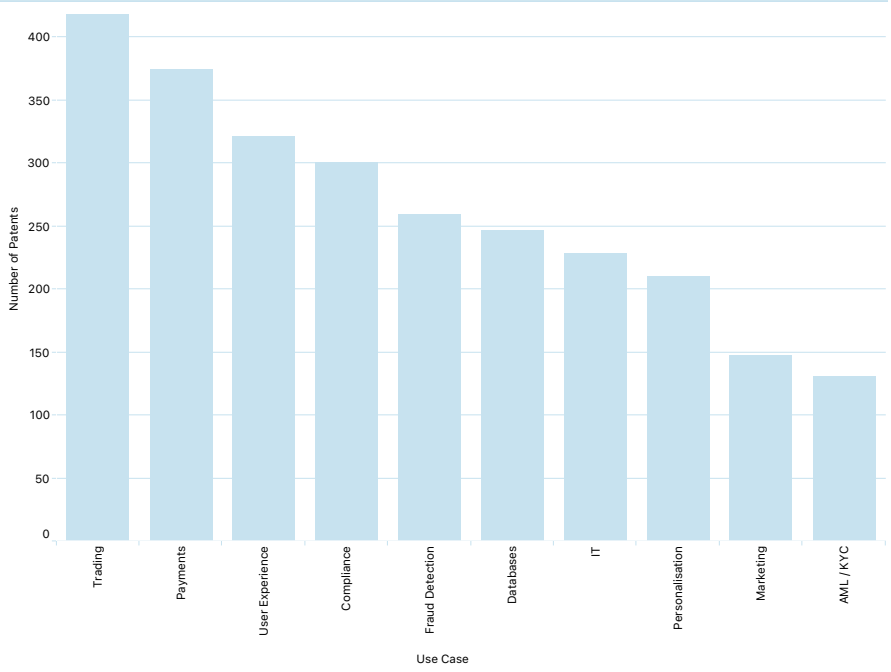
Clearly what banks choose to patent gives us insight into their strategic areas of focus - and where they see opportunity for competitive advantage.

Nearly 15% of all patents filed by banks are focused on trading, followed closely by payments and compliance.

- → Trading patents: relate to market dynamics, investment strategies, and risk management
- → Payments patents: relate to operational improvements in payment security, payment devices, and payment processing
- → User Experience: a broad group including chatbots, user interface design, financial advice, handwriting recognition etc.
- → Compliance: relate to techniques to better manage financial regulations, data privacy regulations, or personally identifiable information, GDPR etc. - such as creating synthetic datasets without identifiable information.
- → Databases: the use and optimisation of databases, including database management, faster database indexing, easier database searches etc.
- → Fraud: Identifying, mitigating, and preventing fraudulent activities. Such as identifying fraudulent transactions, phishing attempts, and payment authentication
- → Recommender Systems: The development of recommendation systems to provide personalised recommendations to users based on their preferences, behaviours, and historical data

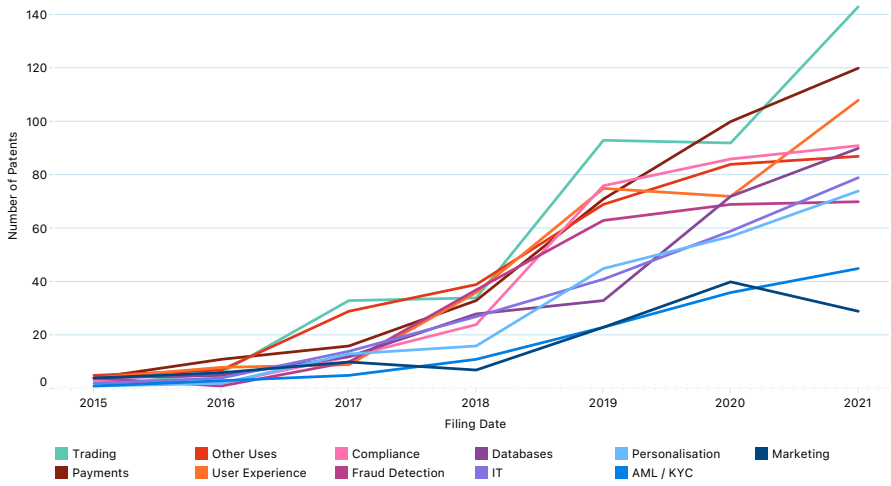
The payment providers in our sample are, perhaps unsurprisingly, highly focused on patents in the payment space, with more than 44% of their AI-related patents in this area.

FIG 24. TOP 10 FOCUS AREAS OF AI PATENTS ACROSS THE BANKS (2010-21)



While the number of patents filed is increasing in all areas, particular areas of growth in the last year include patents related to trading and user experience.

FIG 25. NUMBER OF PATENTS BY FOCUS AREA, BY YEAR OF PATENT FILING



PATENT FOCUS AREAS BY TECHNOLOGY TYPE

Computing is the largest category of AI-related patents, including supercomputers, GPU / CPU optimisation, and cloud computing. This is not a new area of focus for the banks - in fact it has been the leading category of AI-related patents since 2015 (see below) - but evidence of banks' ongoing efforts to optimise their infrastructure and reduce costs in this space.

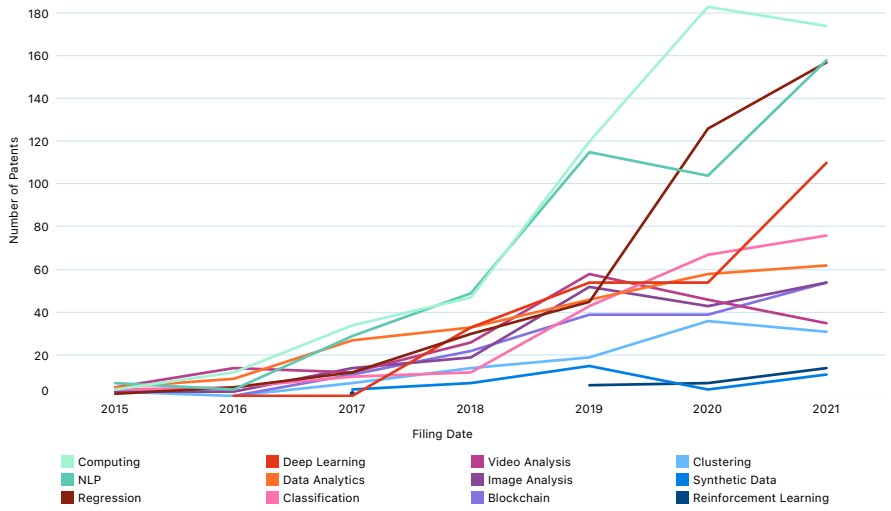
Regression and clustering: again, not necessarily new, but an increased focus area for the banks.

Deep learning: the first patents in this space emerged in 2016, but we have seen a rapid acceleration in 2021 filings. We expect this to continue.

NLP: the second most patented technology in 2021, critical to use cases around customer interaction, market analysis and internal management.

Areas to watch: despite small numbers of patents today, we expect to see increased patents related to reinforcement learning and synthetic data in the years ahead, particularly from banks whose AI research has been increasing in these areas.

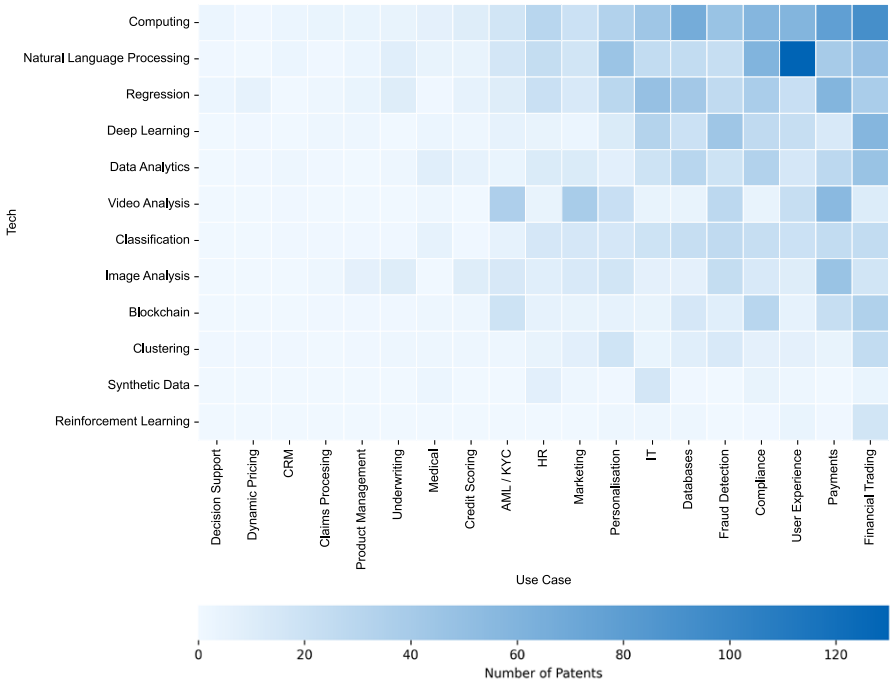
FIG 26. NUMBER OF PATENTS BY TECHNOLOGY TYPE, BY YEAR OF PATENT FILING



The charts below highlight where banks have focused their patents across two axes. The Y-axis reflects the area of technology and the X-axis the business use cases that the technology is being used in.

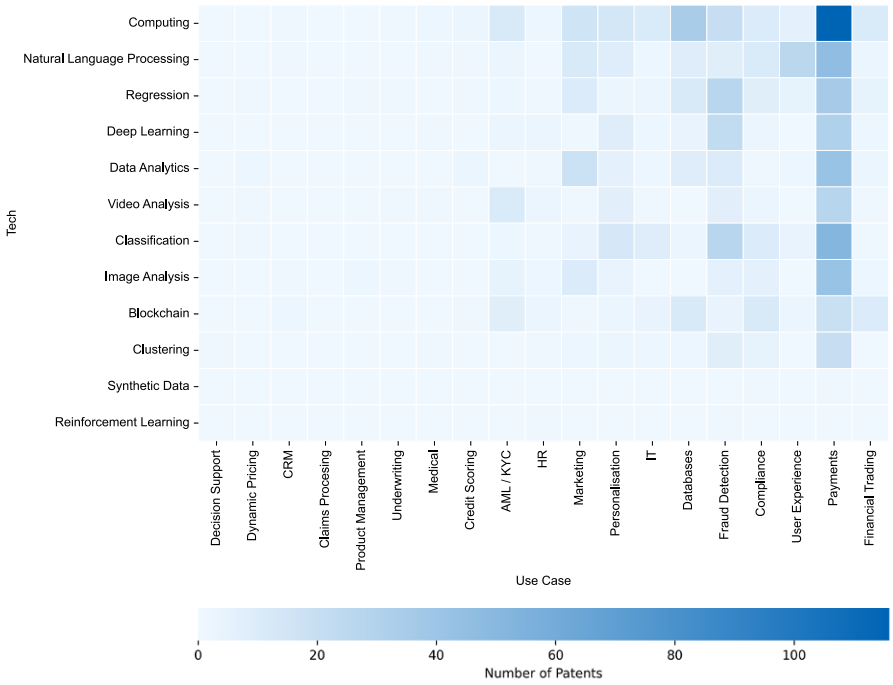
We see a heavy focus on user experience and NLP patents amongst the banks, indicating a strong focus on chatbots and financial assistants, whereas payment providers' focus on payments is clear.

FIG 27. HEATMAP OF AI PATENTS FOCUS AREAS ACROSS BANKS



Note: AI patents categorised by use case (x-axis) and technology area (y-axis). Squares colour-coded relative to the area with the greatest number of patents.

FIG 28. HEATMAP OF AI PATENTS FOCUS AREAS ACROSS PAYMENT PROVIDERS



Note: AI Patents categorised by use case (x-axis) and technology area (y-axis). Squares colour-coded relative to the area with the greatest number of patents.

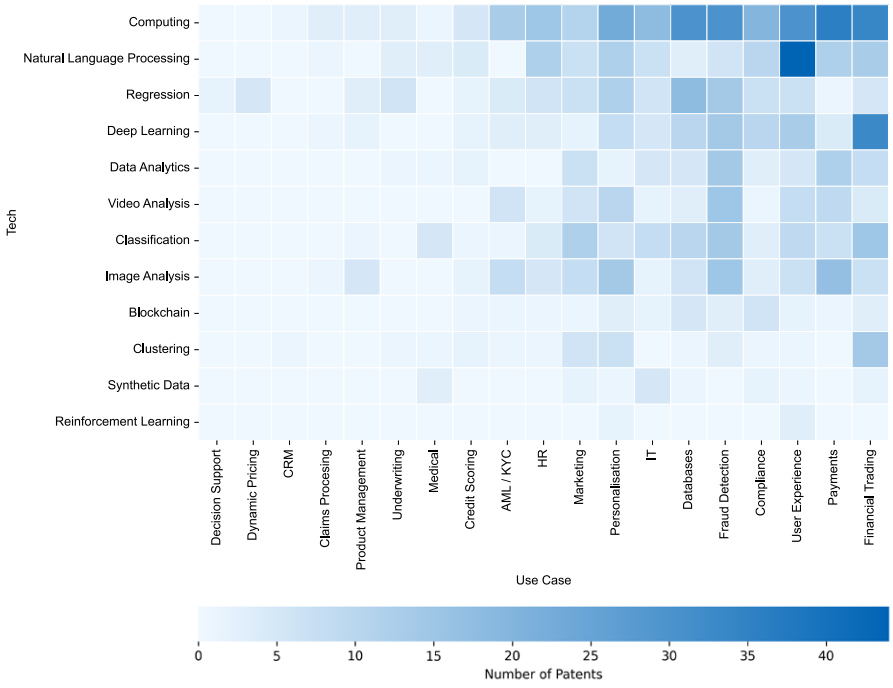
Patent focus clearly varies by company
Comparing the top two banks we can see some patterns emerge:

Bank of America has a pillar of strength in payments and regression is a strong element in the mix, showing that traditional techniques continue to be in play. This probably reflects Bank of America's long-term patent strategies over many years. There is also an interesting mix of (highly rated) patents in video analysis, particularly related to marketing, and fewer AI-related patents related to trading vs peers.

Capital One appears to be more highly focused on trading and computing, with a particular strength in NLP and UX / customer experience.

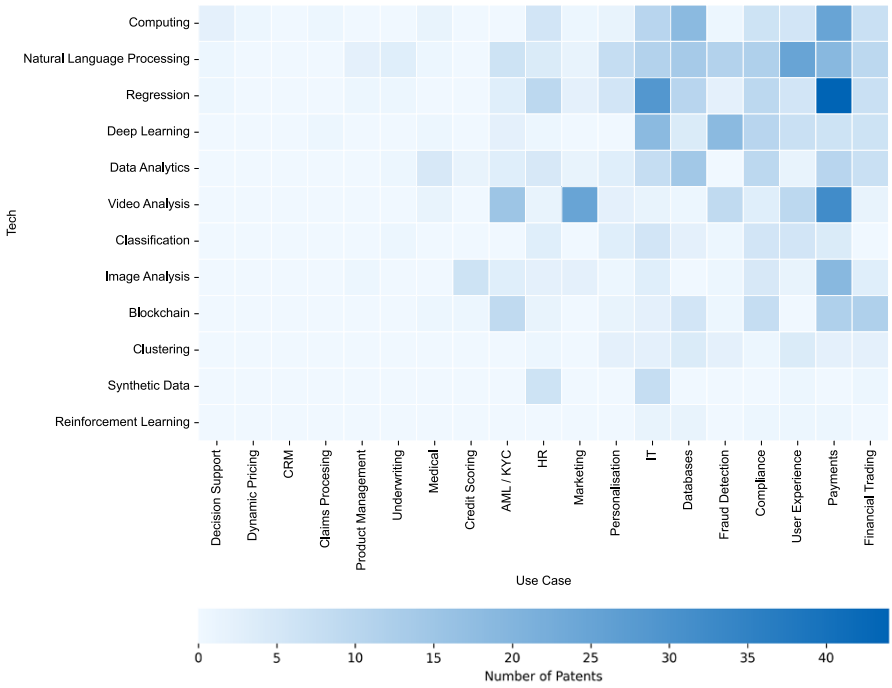
Some areas of relatively low activity are interesting - KYC for example does not appear to be a particularly strong patch for either of these banks.

FIG 29. HEATMAP OF AI PATENT FOCUS AREAS FOR CAPITAL ONE



Note: AI patents categorised by use case (x-axis) and technology area (y-axis). Squares colour-coded relative to the area with the greatest number of patents.

FIG 30. HEATMAP OF AI PATENT FOCUS AREAS FOR BANK OF AMERICA



Note: AI patents categorised by use case (x-axis) and technology area (y-axis). Squares colour-coded relative to the area with the greatest number of patents.

Other interesting findings include:

→ **RBC:** is largely focused on trading, with a speciality in reinforcement learning.

→ **TD Bank:** holds a significant proportion of patents focused on user experience and personalisation (and NLP), as well as underwriting, reflecting the bank's insurance strength.

→ **Wells Fargo:** its focus on computing patents, combined with a number one ranking in terms of Data Engineering talent (see Evident AI Talent Report), suggests a significant focus on data architecture and integration.

PATENT QUALITY

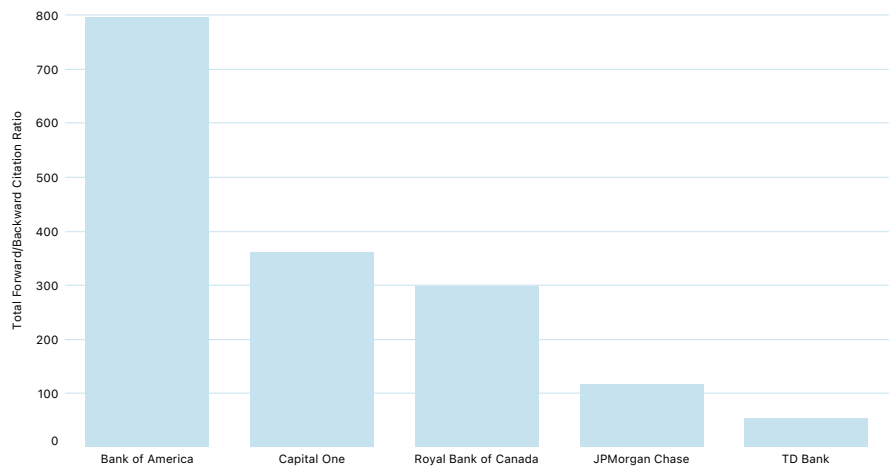
We have assessed the quality of patents across the banks by looking at the ratio of forward to backward citations - though there are challenges with this analysis as we shall see.

→ Backward citations - the number of preceding patents that your patent cites - are a measure of the novelty of the patent. The fewer backward citations, the more unchartered the territory, and the more novel the patent.

→ Forward citations - the number of other patents that cite your patent - are a measure of impact.

By these metrics, Bank of America has a strong position when we consider patent quality, with 14 of the 20 most influential patents published from 2010 to 2021.

FIG 31. TOP FIVE BANKS BY "QUALITY" OF AI-RELATED PATENTS FILED 2010-2021



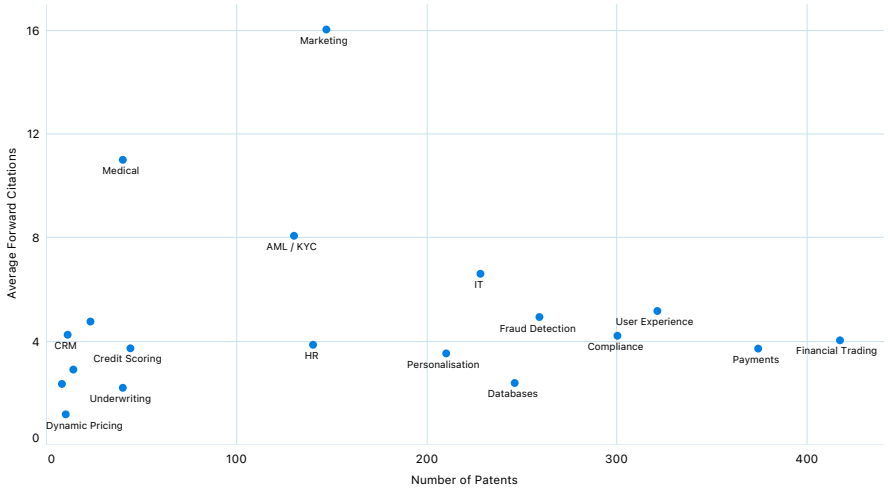
Note: analysis based on ratio of forward to backward citations.

However, this partially reflects the longer legacy of Bank of America's patent work. Capital One's growth in the past five years will not have had as much time to garner recognition (see later).

Additionally, forward citations may not fully reflect the intellectual strength of the work as much as the area of focus. Simply put, if your patent is cited by other patents then it clearly sits in an area where others are also doing patents.

Work in popular categories like video recognition, or marketing (see below), which have many potential end users, may be more popular than more obscure work focused on core banking challenges.

FIG 32. COMPARISON OF NUMBER OF PATENTS VS AVERAGE CITATIONS, BY PATENT FOCUS AREA ACROSS THE BANKS (2010-21)



Bank of America's leading patents cover a range of topics, most of which have potential applications ranging far beyond banking.

Many of Bank of America's top patents focus on image recognition. The #1 top patent covers "Real time video image analysis for providing targeted offers"; #5 covers similar territory for "an appropriate payment account"; #8 is "Identifying pre-determined objects in a video stream captured by a mobile device"; and #9 is "real time video analysis for reward offers". #11 covers using images to "provide health related information". How well these would travel, under the EU AI Act for example, is not clear.

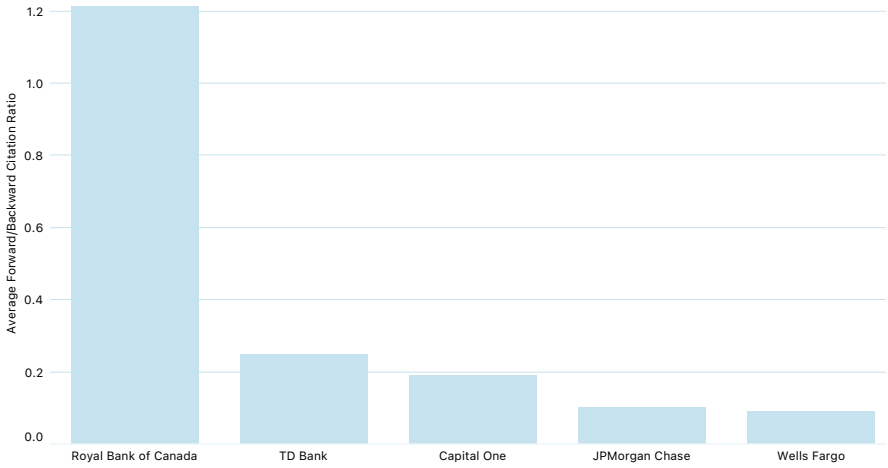
The bulk of Bank of America's patents appear to cover marketing applications ranging from offer generation to capturing real-time feedback. These are likely to be heavily cited at least partially because of their wide applicability across industries.

Other leading patents are in more banking-specific territory - RBC's top patents (at #3 and #4 respectively) cover "Credit score platform" and "Expert knowledge platform" and JP Morgan Chase's single leading patent covers "Business-aware intelligent incident and change management".

If we look specifically at patents filed in 2020 and 2021, the picture is very different

RBC leads the way, with 8 out of the top 20 most influential patents, followed by TD Bank and Capital One. Bank of America falls out of the top 5, into 6th position.

FIG 33. TOP FIVE BANKS BY "QUALITY" OF AI-RELATED PATENTS FILED (2020-2021)



Note: analysis based on ratio of forward to backward citations.

FIG 34. TOP 20 MOST INFLUENTIAL AI PATENTS FROM 2020 TO 2021

COMPANY	TITLE	RANK
RBC	System and method for machine learning architecture for enterprise capitalization	1
RBC	System and method for knowledge distillation between neural networks	2
Capital One	Aggregated feature importance for finding influential business metrics	3
Capital One	Data security scanner for detecting confidential data	4
RBC	System and method for machine learning with long-range dependency	5
RBC	Image recognition reverse tuning test system	6
RBC	Systems and methods for generating graph data structure objects with homomorphism	7
TD Bank	System and method for automatically determining privacy settings for sharing data	8
JPMorgan Chase	Systems and methods for maintaining decentralized digital identities	9
RBC	System and method for generation of unseen composite data objects	10
Capital One	System and method for using passive multifactor authentication to provide access to secure services	11
Bank of America	Multi-layer biometric authentication	12
Capital One	Systems and methods for controlling secure persistent electronic communication account servicing with an intelligent assistant	13
RBC	System and method for controllable machine text generation architecture	14
Capital One	Generating synthetic models or virtual objects for training a deep learning network	15
RBC	System and method for behavioral pattern recognition	16
Capital One	Systems and methods for promoting transaction rewards	17
Capital One	Artificial intelligence-based system and method for conditional electronic transaction processing	18
Bank of America	Systems for real-time event manipulation prevention through artificial intelligence-assisted quantum computing	19
Bank of America	System for context-based data storage scrutinization and capture	20

THE ECOSYSTEM AND ITS USES

No bank is an island.

They all operate within an ecosystem of universities, tech firms, advisory firms, data players and regulatory institutions. The culture and nature of a bank is at least partially formed by the company that it keeps - the people that it hires, the firms it collaborates with, the tech that it sources and the ideas that it is introduced to.

The players with whom banks interact vary by market and by bank but would typically include:

→ **Universities:** These organisations have historically been at the cutting edge of AI research and development. They offer expertise, fresh perspectives, and highly skilled talent.

→ **Research Institutions**: There is a growing range of non-academic research institutions that participate in AI research. Examples include the Alan Turing Institute in London and the Vector Institute in Toronto

→ **Tech Companies:** Ranging from large, established tech companies that offer AI solutions to startups with innovative propositions. They will claim to (and often do) provide advanced AI tools and services. Bank management will often be uneasily aware that the reference to "*disrupting the financial services industry*" in the startup's pitch deck is probably referring to them.

- **FinTech Firms:** This specialist subset specialise in financial technology. They may have developed specific AI tools or models for financial services applications, such as risk assessment, fraud detection, and customer service.
- **RegTech Firms:** These are companies that provide technology solutions to help with regulatory compliance. They can help banks understand and navigate the complex regulatory landscape associated with AI in banking.
- **Cloud Providers:** Whilst this is a relatively consolidated industry, depending as it does on huge capital outlays, cloud providers continue to innovate and provide additional layers of services and tools to support their customers. Indeed, banks' IT leaders are increasingly concerned about the risk of getting locked into hugely expensive contracts with these providers.
- **AI Specialists and Consultancies:** These firms specialise in providing AI solutions and advice. They can assist with everything from strategy and implementation to training and support.

→ **Data Providers:** These organisations specialise in collecting, analysing, and selling data, which can be useful for training AI models or operationalising data-intense business processes.

→ **Industry Consortia or Alliances:** These are groups of companies that work together to advance a specific technology or set of standards. By joining such groups, banks can stay at the forefront of AI innovation and work with others to shape the future of the regulation of AI in banking.

→ **Government Agencies:** Some government agencies will have initiatives or programmes to support the adoption of AI in different industries, including banking. These partnerships can provide funding, resources, and policy guidance. This also covers the regulatory bodies with whom banks are increasingly discussing AI issues.

→ **Non-profit Organisations:** Some non-profits focus on AI research, standards, ethics, and policy. They can provide valuable insights into the social, legal, and ethical implications of making responsible AI a reality.

→ **Open source community:** Through tools like Kaggle, banks can access the combined energies and intellect of the wider community of software and AI developers. Open source approaches can lead to more efficient, and potentially better-debugged, tools. That one of the current debates in the industry is between open source-enhanced LLMs (like iterations on Facebook's LLaMA) and the increasingly "black box" approach of OpenAI's GPT-series shows that this is a very live option for banks.

The benefits of working with partners are varied, but they include

→ **Talent Acquisition:** Universities are key here, both because of direct recruitment but also because the training offered tends to proliferate across industry.

→ **Research Collaboration:** Universities are often at the forefront of cutting-

edge research in AI. By partnering with universities, banks can access this research and leverage it to improve their own AI initiatives.
→ **New Products:** Every bank is on its own "buy or build" journey but nobody can build everything internally so the mix is key.
→ **Idea Generation and Development:** Students and faculty from universities, outside consultancies or think tanks can bring fresh perspectives and innovative ideas to the bank's AI development or, for example, Responsible AI practices.
→ **Proof of Concept and Pilot Testing:** Partners and providers can help banks develop and test new AI technologies in a controlled environment before they are rolled out on a larger scale. This can help banks identify and address any potential issues before the technology is fully implemented. Examples include the sandboxes which regulators such as the UK's FCA are increasingly keen to offer.
→ **Training:** Outside organisations can help banks train their existing staff in the use of AI technologies. This can involve workshops, seminars, or online courses that help employees understand the basics of AI and how it can be applied in a banking context.
→ **Data Sharing:** Partners and providers might be willing to sell or share data that can help train and refine the bank's AI systems. This data could come from a variety of sources and be used to enhance the bank's AI capabilities in various areas, such as fraud detection, credit risk modelling or customer segmentation.

HOW BANKS ORGANISE TO EXPLORE AND CAPTURE VALUE

Strategic Approach

There are multiple trade-offs and decisions inherent in working within an ecosystem. These speak to the strategic purpose and rationale for participating. As examples of decisions that need to be made...

... What is the bank trying to achieve?
Banks are at different stages in their AI journeys and therefore need different things. When ChatGPT launched, banks found themselves using their ecosystems differently. One European bank used a university partnership to run workshops establishing what the opportunity might be and how best to access it. By contrast, a North American bank, having done multiple research projects with local universities, was able to swing into direct action almost immediately.

.... How global should the bank go?
Most banks are focused on building their domestic ecosystem. ING Groep for example has helped build an intricate local network that supports the local AI economy. A few banks operate on a more global basis. Goldman Sachs has multiple university relationships in India. RBC manages relationships on at least three continents (Canada, France, Luxembourg and Israel). This is striking given the Canadian bank's concentration of internal talent in Toronto.

... Is the bank giving or receiving?
Talking to bank executives it is striking how some refer to their responsibility to provide support to their local AI community. One spoke of "*supporting the USA*" in this mission. Clearly the more that can be shared the bigger the opportunity for a positive feedback loop to develop, for example in open source work.

TEAMS

Banks inevitably organise their market-facing organisations differently - depending on strategy, organisational capacity and maturity and legacy relationships. In the early days of AI innovation, these relationships are likely to be held closer to the corporate centre, but then they will spread across the organisation as individual business units build out competency in the AI domain. Of course, this will not hold true in every instance - for example, we have encountered banks that had a hugely diverse set of chatbot suppliers, until the number was eventually rationalised from the centre.

Key teams likely to be involved:
→ **Research and Development (R&D) Team:** given their responsibility and recruitment base form universities they often hold close ties to academic partners.

→ **Innovation or Digital Transformation Team:** These teams are often tasked with identifying, selecting and implementing AI within the bank.
→ **IT/Technology Team**: This team manages the bank's technology infrastructure and works closely with AI solution providers.
→ **Data Science Team:** They will work to capture the best tools and techniques.
→ **Key functional teams:** Risk Management; Regulatory Compliance; Procurement; HR; Learning & Development; Marketing; Customer Service.
→ **Strategy Teams**: AI is increasingly central to banks' strategic future so the area will be of great interest to bank strategy executives. They may, for example, build relationships with key consulting firms.

Clearly aligning these conversations - both encouraging and disciplining the web of contacts - is critical. We will discuss more about how banks are approaching this in our forthcoming AI Leadership Report.

ACADEMIC RELATIONSHIPS
Types of Relationship
Given the high volume of staff recruited directly from universities it is inevitable that these relationships can be tight knit. There are three main areas of partnerships with academic institutions.

Teaching
Working with universities to expand the volume of teaching to grow the scale of AI talent generation. Options might include sponsoring programmes or events. This also is an opportunity for bank staff to get exposure to teaching from senior academics at the cutting edge of the field.

FIG 34. SAMPLE BANK / UNIVERSITY TEACHING RELATIONSHIPS

BANK	UNIVERSITY	DETAIL
Banco Bilbao	Universidad de Navarra	AI + data analysis research
Crédit Mutuel	University of Strasbourg	Co-sponsored "Data Sciences and Artificial Intelligence" Chair
KBC Group	Faculty of Economics and Business Administration, Sofia University	Educational initiatives in AI field
DBS Bank	Singapore University of Technology and Design	AI workshop
Royal Bank of Canada	Western University Canada	New courses in AI and data analytics
Royal Bank of Canada	Université du Luxembourg	AI workshop

Source: Evident research

Accelerator
Supporting the creation and development of startups, usually by students, staff or alumni of the university. Given the cutting edge nature of the industry it is not surprising that universities are a hotbed of start-up innovation. Collaborating with internal accelerator programmes can provide banks with advance notice of the future of the sector. A leading example of this is Capital One's support for the incubator at the University of Maryland. This focuses on machine learning and data analytics.

Research
As we have seen in the earlier chapter on Research, some banks are building in-house AI research capability - focusing on pure and applied research. However, many banks choose to closely partner with universities to access cutting-edge research instead.

FIG 35. SAMPLE BANK / UNIVERSITY RESEARCH RELATIONSHIPS

BANK	UNIVERSITY	DETAIL
Bank of America	Harvard Kennedy School	Council on the Responsible Use of Artificial Intelligence
Bank of Montreal	University of Toronto	Program Integrating Artificial Intelligence and Humanities
BNP Paribas	University of Luxembourg	First Luxembourgish AI Model created with BNP Paribas
BNP Paribas	Bocconi University	AI in Mortgage Ticket Management
BNY Mellon	Maastricht University	Data Science and AI students work on business cases
Capital One	University of California, Irvine	Grant for studying AI in finance
Goldman Sachs	Indian Institute of Technology Kharagpur	AI solutions in Fintech
Goldman Sachs	International Institute of Information Technology Hyderabad	Center of Excellence for AI and Emerging Technologies
ING Groep	University of Twente	Application of AI to complex datasets in the financial sector
ING Groep	Delft University of Technology	AI Fintech lab
JPMorgan Chase	Carnegie Mellon University	AI maker space
JPMorgan Chase	McKelvey School of Engineering (Washington University in St. Louis)	Sponsoring awards for AI research
CBA	University of Technology Sydney	AI research
Mastercard	Howard University	Addressing racial bias in AI-driven credit approval processes
Royal Bank of Canada	University of Toronto	Centre of development in machine learning and AI
Royal Bank of Canada	Ben-Gurion University	AI for cybersecurity
Wells Fargo	Stanford	Human-Centered Artificial Intelligence (HAI) + the Platform Lab
Wells Fargo	MIT	IBM Watson Artificial Intelligence Lab.

Source: Evident research

BNY Mellon is a good example of a bank with very close university research partnerships.

Isbank, the largest bank in Turkey, though significantly smaller than any banks in the Index, has a similar model. It has established an impressive partnership with Koc University, creating an AI Application and Research Center focused on co-creating cutting-edge research.

In the UK, HSBC works with the Alan Turing Centre to drive research on AI in Financial Services. Given the latter's role collaborating across multiple banks this can be considered an arm's length collaboration scheme.

Supporting and collaborating with academics who are researching new techniques and tools can provide a real boost to a bank. And given that many of the collaborators from the bank may be former colleagues of the academics involved this may provide for an added layer of trust to the conversation.

COMMERCIAL RELATIONSHIPS

Business relationships will cover the full gamut of services and products - ranging from strategic advice to tools to computing power. As an example, we can see that there are multiple providers of AI tools in the field of fraud prevention. Across the range of tools and use cases, commercial providers will comprise a mix of early stage startups and more established firms deploying AI to strengthen their offering.

One group that is deeply entrenched in the banking industry are the cloud computing providers. The transition to cloud computing is one of the earliest indicators that a bank has started on the AI journey (although it alone does not constitute AI traction). Given concerns about security, control and even sovereignty - not to mention a lingering concern that the Big Tech players may have designs on the financial services industry - the move from purely on-prem computing is rarely as easy a move as the attractive headline economics might suggest it should be.

> We strongly believe in collaborating with and learning from universities and research institutions – such as Carnegie Mellon's MSAII program and MIT's CSAIL – to explore what can be made possible with AI. Robust understanding of state-of-the-art capabilities helps inform how we design innovative, impactful AI solutions.
>
> *Mike Demissie, Global Head of Innovation and Advanced Solutions, BNY Mellon*

FIG 36. SAMPLE CLOUD COMPUTING PROVIDER RELATIONSHIPS

CLOUD PROVIDER	SELECTED BANKS	REGION
AWS	BBVA	EU
	National Australia Bank	RoW
	Westpac	RoW
Google Cloud	Banco Bilbao	EU
	Bank of Nova Scotia	Canada
	CaixaBank	EU
	Commerzbank	EU
	Deutsche Bank	EU
	Intesa SanPaolo	EU
	PayPal	US
	SEB Group	EU
	Wells Fargo	US
IBM	Banco de Sabadell	EU
	Crédit Mutuel	
Microsoft	Morgan Stanley	US
	Standard Chartered	UK
	Swedbank	EU
	TD Bank	Canada
	UBS Group	EU
	Unicredit	EU
	US Bancorp	US
	Wells Fargo	US
	Westpac	RoW

Source: Evident research

CASE STUDY:
BBVA AND AWS AI PARTNERSHIP

A recent partnership announcement between AWS and BBVA shows how banks straddle both in-house and vendor capabilities. The 1,000 + data scientists at BBVA's AI Factory will have full use of Amazons' machine learning platform - Sagemaker - to build, train and deploy machine learning models for any use case. Moreover, the bank's almost 3,000 data engineers and architects will see an amplification in the scalability, flexibility and efficiency in managing large pools of data.

Heightened model operationalisation capacity and improvements to data hygiene provide important plumbing for more complex applications such as LLMs. Here lies the shiny promise of a partnership with a cloud compute powerhouse like AWS: BBVA will have full access to Amazon's LLM - Titan - providing a fully managed service that makes foundational models available via an API, to explore the potential of advanced technologies and to help create innovative financial solutions.

Whilst examples like this don't necessarily differentiate banks in terms of their IP, it does show how concerted efforts to build in-house AI capability through well-staffed centralised units can be married with the production power and scalability of Big Tech partners. The risk that needs to be managed, however, is that banks become overly dependent on one provider - leaving them at risk of lock-in to an underperforming tech stack or on the wrong end of aggressive pricing increases.

OPEN SOURCE RELATIONSHIPS

Banks look to open-source IT solutions for cost-effectiveness, flexibility, and innovation speed. However, they must carefully manage risks related to security, compliance, and support. Community engagement is key for capturing ongoing open source advancements and best practices. There are inevitably several flavours of open source.

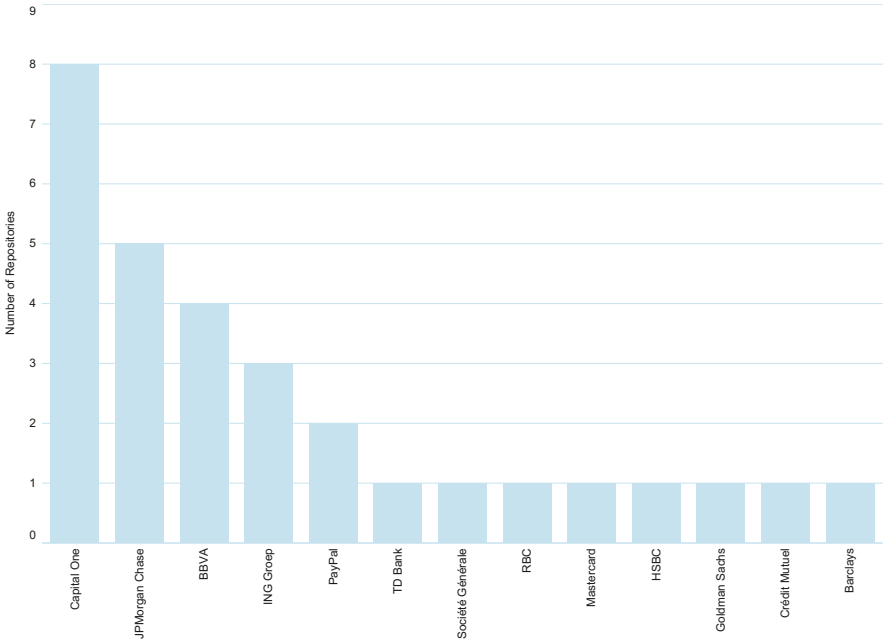
Of the 60 banks and payment providers we track, 38 of them have a presence on GitHub with at least one repository containing available code. 12 of the companies have more than 20 repositories with a commit in the last year across several different topics. Six out of the top 12 are based in Europe - with a particularly strong performance from BBVA.

When looking at those who open-source code related to AI or Machine Learning, we find 13 companies that have at least one repository with at least one commit in the last year.

Some of the most popular AI and Machine Learning repositories are:

- → Capital One's Data Profiler, which features a pre-trained deep learning model for efficiently identifying sensitive data in your dataset.
- → Borealis AI's advertorch, a Python toolbox for adversarial robustness research.
- → Goldman Sachs' gs-quant, a Python toolkit for quantitative finance.

FIG 37. NUMBER OF ACTIVE GITHUB AI / ML-RELATED REPOSITORIES, BY COMPANY



We have been humbled and changed by the incredible fintechs we have worked with, and we understand first-hand the power of collaboration to evolve and unlock opportunities for our customers, clients, colleagues and the communities in which we operate

Mariquit Corcoran, group chief innovation officer, Barclays

CASE STUDY
OPEN SOURCE AND CAPITAL ONE

Capital One has been a major champion of open source technology - In fact, it launched the Capital One Open Source Program Office in 2015. Capital One has for some time been open-sourcing software that would traditionally have been kept in-house; in return, interested developers offer feedback and ideas for improvements. Developers are keen to do so for a variety of reasons. It allows them to show off their talent, potentially providing employment or other remuneration opportunities. Many are also inquisitive and keen to play with sophisticated problems, interesting data and - potentially - real world consequences.

In addition to its "open-source first" development approach, Capital One is also financially supporting the ecosystem with investments into open source projects like the Cloud Native Computing Foundation and

Python, as well as sponsoring major open source conferences.

For a bank like Capital One the open source community clearly provides an opportunity to support the emerging AI ecosystem and engage with talent. That it may also help solve problems and build more robust solutions is clearly also a strong benefit.

CASE STUDY
OPEN BANKING IN THE UK

Since 2018, the Open Banking protocol in the UK has made it easier for banks and their customers to share data. With the Barclays Open Banking platform, customers can access aggregated accounts, budget tools, and initiate payments. This is regulated by the Financial Conduct Authority (FCA) which helps foster a secure ecosystem.

Barclays Bank has formed a strategic third party partnership with corporate venture builder Rainmaking, through which it will launch a new suite of initiatives for global fintechs. AI is used to analyse the financial data, enabling trend identification, fraud detection, and tailored recommendations.

As a result, the banking system can be made cheaper and more efficient for a bank and its consumers.
→ Customers can then see their account information from other banks and use their accounts to make payments on other websites.
→ Open Banking can increase bank's security by training AI to recognise fraudulent transactions.
→ AI-powered financial apps can analyse spending habits and offer tailored recommendations to help users save money and optimise their financial decisions.
→ Open banking also facilitates compliance with regulations, such as the Second Payment Services Directive (PSD2) in the European Union, and it collectively positions banks to adapt to changing customer expectations and market dynamics in the digital age.

↓

We will emphasize building specialized technologies and capabilities that help us deliver differentiated value to our associates and customers. We will leverage open source or commercial offerings for generic capabilities

Prem Natarajan, Chief Scientist & Head of Enterprise Data and AI, Capital One

THE BUY VERSUS BUILD DILEMMA

Banks must carefully evaluate the "buy versus build" approach when integrating AI into their operations. The decision can be taken at multiple levels - so buying in does not necessarily mean outsourcing innovation. The innovation may, for example, lie in the use to which a tool is put rather than the creation of the tool itself.

Buying AI solutions from external vendors offers several advantages, including rapid implementation, access to specialised expertise, and a lower initial investment. It can also free up internal resources to focus on core banking operations. However, pre-built solutions may not fully align with a bank's specific needs or long-term strategy. Moreover the risk of lock-in to an underperforming tech stack or over-priced suppliers is always a challenge.

Building in-house AI solutions provides a high level of customisation, allowing banks to tailor AI functionalities to their unique objectives. This approach, while potentially offering greater strategic alignment and competitive advantage, requires significant investment in talent, infrastructure, and ongoing maintenance and development. There are also challenges around staying up to date on new technology and bringing new staff up to speed on internal tooling - for example one bank's programming language can turn from competitive advantage to deadweight anchor as the industry standard evolves.

Inevitably, the senior managers we speak to have different takes on the choices.

These are not new questions for banks - nor are the answers going to be new. What is clear is that few banks are adopting a "*not invented here*" syndrome - and indeed how could they in the age of ChatGPT?

Balancing the changing dynamics as the industry matures is a key challenge for management. We will discuss this further in our upcoming AI Leadership report.

Banks make investments into early stage AI companies for many reasons.

Sometimes an investment is just that - an opportunity to make money. Much of the money being deployed in AI is essentially client cash being invested through bank's VC or PE vehicles - and many of the companies being supported have AI applications with limited immediate or obvious impact on banking.

But there are many other, more strategic reasons, why banks might benefit from investing in AI companies:
→ **Access to innovation:** AI startups are often at the cutting edge of technology. By investing in them, banks get direct access to the latest advances, ideas and can potentially integrate these technologies into their operations.
→ **Market intelligence:** Working with startups will deliver insights into new market trends and technology. Getting and staying ahead of the curve, as well as potentially capturing competitive insights, can be critical.
→ **Partnership opportunities:** Banks can form strategic partnerships with the AI startups they invest in. These partnerships can theoretically provide mutual benefits, such as joint marketing initiatives, co-development of products or services, and cross-selling opportunities. Sometimes these opportunities look better in Powerpoint than in reality.
→ **Competitive positioning:** By investing in AI startups, banks can position themselves as innovative and forward-thinking, which can enhance their reputation with customers, investors, and other stakeholders. A constant question for banks working with startups is how far they should be encouraged to work for competitors. It is clearly the way to maximise value creation but does pose questions if banks have provided market-sensitive insight or data. Usually the data-learning flywheel means that cross-company work creates better products which should act in the interests of all. However, not all stakeholders will necessarily make the same value-creation or -capture calculations.
→ **Acquisition pipeline:** Investing in AI startups can serve as a pipeline for future acquisitions. If a startup's technology or business model proves to be particularly valuable, the bank might decide to acquire the startup to bring its technology or expertise in-house.

CASE STUDY
EXAMPLE OF SUCCESSFUL INVESTMENT: CAPITAL ONE AND SNOWFLAKE

Capital One invested in Snowflake, the cloud-based data storage and analytics service, which offers "data-as-a-service". It did this at both Series D and F through Capital One Ventures. This would have led to significant capital upside when the firm IPOed in 2020.
→ Meanwhile, Capital One used the company's services to support its migration to the cloud. Doing this in such a confident manner built a strong platform for the firm's ongoing investment in an AI future.
→ Capital One has at least 14 staff members with "Snowflake" in their title. In this, the bank is not alone - we track dozens of similar roles across our AI talent base, at dozens of banks.
→ The strength of the partnership means that Capital One now offers software products through the Snowflake online marketplace.
→ The combination of equity return, support to internal transformation and the opportunity to innovate new products and revenue lines for the bank showcases the potentially large impact of a well chosen investment.

In this chapter, we try to understand the approaches banks are taking to AI investments, teasing out which banks appear to be focusing on more strategic investments (for long-term benefit to the bank's operations) versus ventures investments (for return). The best investments, of course, do both.

INVESTMENT VOLUMES

Banks have continued to ramp up their financing of AI companies, with the number of deals in this space growing at a CAGR of 15% from 2017 to 2022 (with a significant bounce in 2018).

Note that these numbers are the number of deals done and, as you can see from the chart below, many banks have been making repeat investments into companies funded in previous years, rather than new companies. 29% of all AI deals done in 2022 were into companies that one of the banks in our coverage had previously invested in.

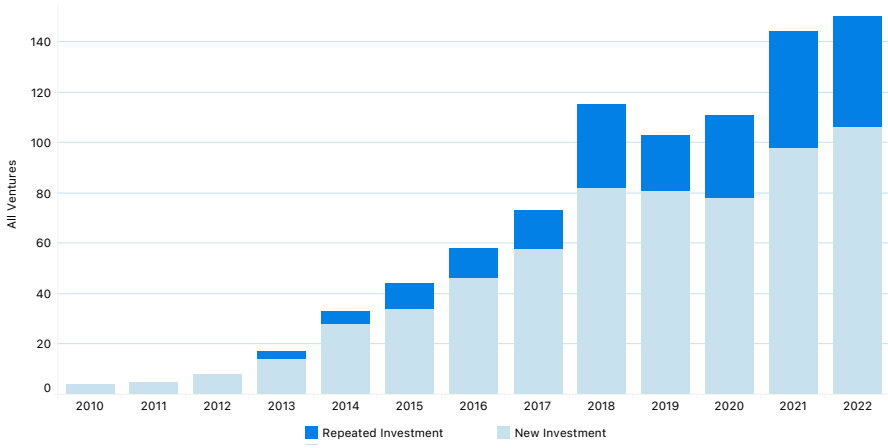
CASE STUDY
EXAMPLE OF SUCCESSFUL INVESTMENT: TD BANK AND LAYER 6

In the initial period of post-AlphaGo AI enthusiasm there was a strong tendency for tech companies to indulge in 'acqui-hires'. As freshly minted PhDs spun businesses out of universities which struggled to get market traction, many of them were snapped up by BigTech firms eager to bolster their talent pools. The underlying businesses were discarded but the talent was brought on board, much of the headline 'acquisition cost' actually being generous retention bonuses. Many of these staff then ended up continuing their research in the Big Tech firms. It is striking that there is relatively little evidence of banks adopting similar approaches in their war for talent.

In early 2018, however, TD Bank acquired Layer 6, originally founded in 2011, which provided a strong infusion of talent. The bulk of the early research work done at TD Bank was delivered by Layer 6 operatives. The organisation retained a semi-independent status, including separate branding, while CEO and Co-Founder, Tomi Poutanen, became Chief AI Officer at the bank. The aim was to ensure that recruitment could continue - as could a focus on leading edge research. The firm continues to work with third parties - for example, with the Toronto healthcare sector.

However, the challenge with this acqui-hire model is that the talent who founded the company may leave the bank. Tomi Poutanen, for example, left TD Bank in April 2022 to start a new venture.

FIG 38. NUMBER OF INVESTMENTS MADE INTO AI COMPANIES BY BANKS (2010-22)



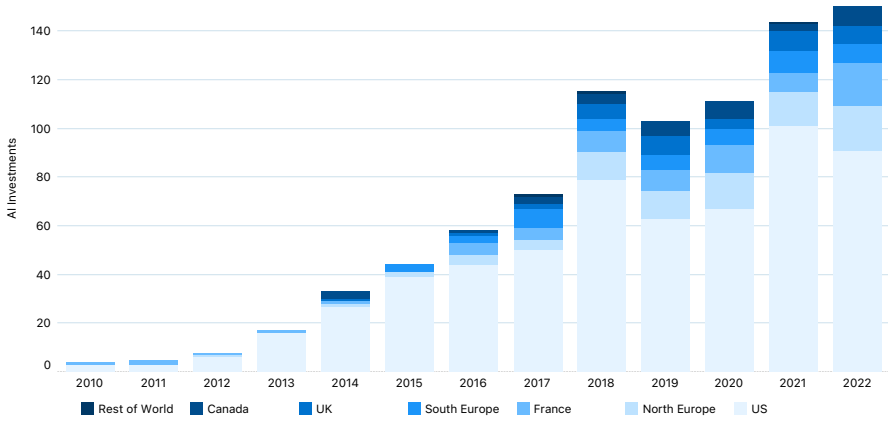
Source: Crunchbase

US banks leading the way; Europeans playing catch-up
Comparing banks in different regions, US banks have long been leading the way in terms of the number of investments they make into AI companies. However, European banks - particularly the French - are increasingly focusing in this space. Back in 2015, 89% of AI-related investments were made by US banks. This has since decreased to 61% in 2022.

These are the number of deals done - and not the investment cash. Given the differential scale of US investment rounds compared to Europe, this methodology is almost definitely underplaying the preponderance of investment dollars flowing to startups from the US banking industry.

Where does investment go?
The US leads not only in terms of who is making the investments, but also where the investment is going. 60% of all AI companies invested in by the

FIG 39. NUMBER OF INVESTMENT DEALS IN AI COMPANIES, BY REGION OF BANK HQ (2010-22)



Source: Crunchbase

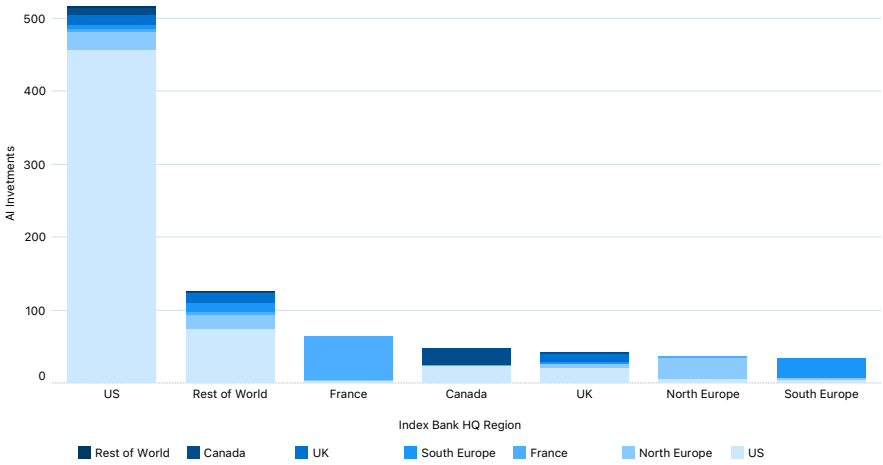
banks are based in the US. Domestic deal-making is also strong: 88% of US-based companies receiving investment were made by US banks.

However, US banks' global perspective means that they also heavily invest overseas, firstly in Rest of World, but also in Canada and the UK.

Europe's performance is decidedly mixed
US banks make more investments in UK based AI companies than UK banks do. Indeed, UK banks are more likely to make an investment in a US AI company than a UK one: 38% of AI investments made by UK banks from 2010 to 2022 were into US companies, compared to 27% into UK companies.

By contrast, French banks dominate their share of domestic investment rounds. Domestic banks make more investment in AI companies in France than they do in the UK. Given the wider disparity of AI investment between the two countries this is a striking result. Indeed, in every other European market domestic players dominate their local investments. Canada receives a lot of US investment but Canadian banks broadly match this.

FIG 40. AI TARGETS OF BANKING INVESTMENT, BY LOCATION (2010-2022)



Source: Crunchbase

The top five AI investors are US banks
The top five banks made over 50% of all investments in the time period.

Wells Fargo is the clear leader in this space, over this time period, making 157 AI-related deals from 2010 to 2023. However, 130 of these were made by Norwest Venture Partners, where Wells Fargo is the main institutional limited partner, and are therefore less likely to be strategic. By contrast, the 12 AI deals made by Wells Fargo Strategic Capital - which "invests in fast growing early to late-stage private companies that tend to align strategically with Wells Fargo" - could indicate a more strategic area of focus.

Goldman Sachs ranks second, with 118 AI investments made by a wide range of the bank's subsidiaries.

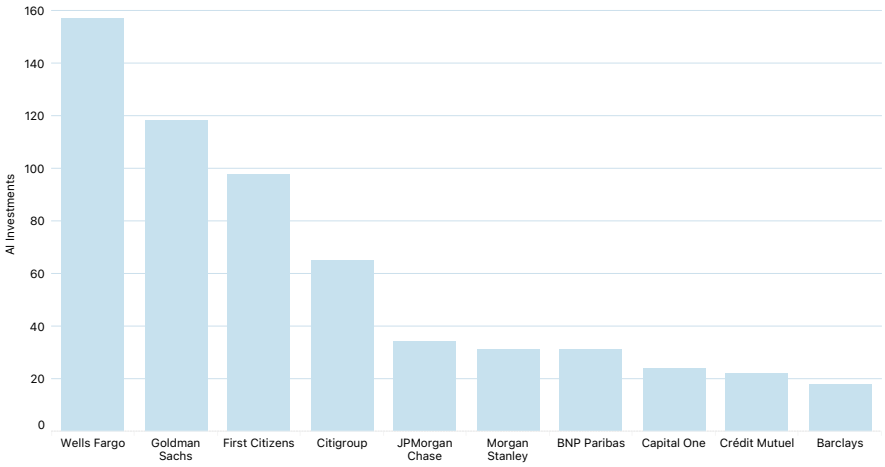
First Citizens's acquisition of the assets of Silicon Valley Bank has propelled it into 3rd place. How sustainable this position is, or how transferable the potential IP to the wider bank, remains to be seen. It is however hard to imagine that it will have the same impact as if invested organically over a longer time period.

Citigroup and JPMorgan Chase round out the rest of the top five.

It is French banks who lead the European charge - BNP Paribas ranks joint 6th, alongside Morgan Stanley, in terms of the total number of AI investments, followed by Crédit Mutuel and the UK leader Barclays.

The story is slightly different when we simply look at the number of companies invested in, rather than the number of deals.

FIG 41. TOTAL NUMBER OF AI INVESTMENTS, BY BANK, 2010-2023 (TOP 10 BANKS ONLY)

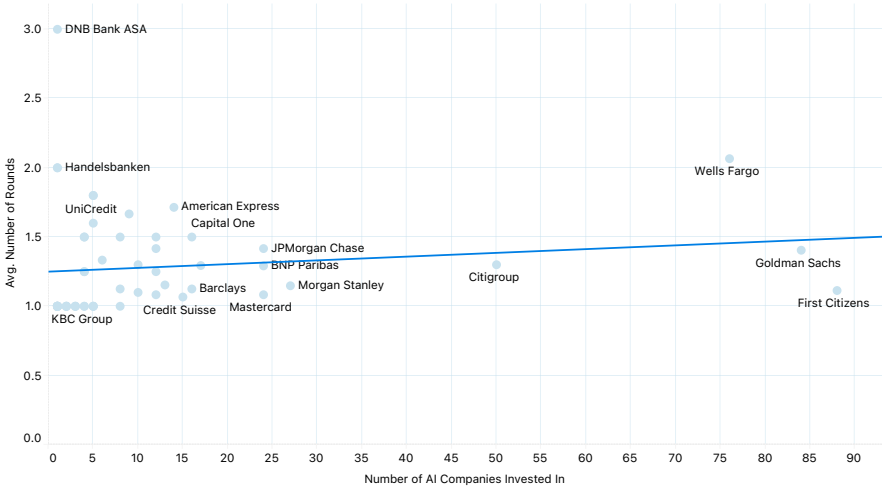


Source: Crunchbase

US banks still lead the way in terms of number of investments, but the order shifts. First Citizens has funded the most companies - perhaps reflecting the pedigree of SVB's approach to its market - but only invested in them just over 1.1x (e.g. it has rarely done follow-on rounds nor perhaps built a longer term relationship with some of its investee base).

Wells Fargo ranks 3rd in terms of number of unique companies invested in, but has typically participated in two rounds per company, indicating longer-term relationships with their investees.

FIG 42. COMPARISON OF AVG. NUMBER OF ROUNDS PARTICIPATED IN RELATIVE TO NUMBER OF COMPANIES INVESTED IN, BY BANK (2010-2023)



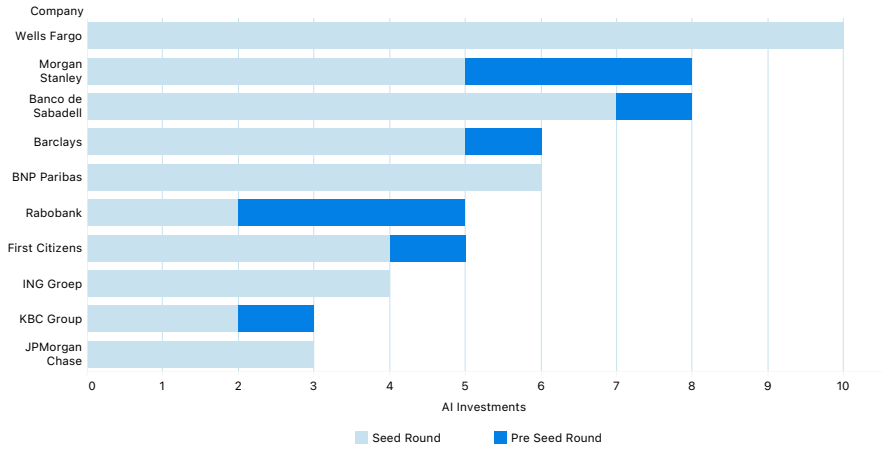
Source: Crunchbase

European banks invest early
When we look at investments made at angel, pre-seed, and seed round, European banks are better positioned. Major US banks Wells Fargo and Morgan Stanley lead the way, but six of the top 10 investors at this early stage are European.

The company they keep
Clearly, no bank investment team acts alone. They operate in an environment where information and deal flow is highly valued. Knowing what other investors are doing and leading on successful deals is considered a mark of success. Other banks are merely one amongst a wider set of investors - but they are ones that inevitably have a special relationship due to competitive concerns.

Considering the mix of banks' relationships with unique AI investment targets, we have sorted them into solo (only one bank in our universe has a relationship with the company), first investor (whereby other banks invested in the firm in a succeeding round) or follower investor (where another bank in invested in an earlier round). This is not a definitive measure of success or leadership but it does hint at different investment profiles.

FIG 43. NUMBER OF EARLY STAGE AI INVESTMENTS (PRE-SEED, SEED ROUND), BY BANK (2018-2023)



Source: Crunchbase

Looking at the 20 banks with the largest number of individual investments, we can see different investment profiles
→ Rabobank has invested in a dozen AI firms in our universe - and there is no overlap with any other banks in our data set.
→ By contrast, Capital One was alone in less than half of its investments - and the number of deals where it was first versus following is roughly equal.
→ JPMorgan Chase has a similar profile, although a higher relative tendency to be a follower. Banco Santander and PayPal also tended to be follower investors.
→ French banks also show a high propensity to work on the same companies.
→ Of the three largest investors, Wells Fargo and First Citizens appear to have less overlap with other banks relative to the scale of their portfolio, whereas Goldman Sachs is slightly more likely to follow other banks than the average.

INVESTMENT FOCUS AREAS
Not all AI investments are necessarily going to directly impact a bank's means of doing business.

Asking the question: "Would a bank, in the usual course of business, be a customer of this service?" of the investments made by the banks in 2022, we calculate that the answer (across financial service, core administrative and technology use cases) is roughly two thirds of the investments would meet these criteria. Roughly one third of investments were not banking-related, focused instead on areas such as healthcare, transportation, commerce and apparel, agriculture, and tourism.

This is obviously an inexact process: as an example, we would say yes to RBC and JPMorgan's debt financing of Lendbuzz's "auto finance platform for people with a thin or no credit history" but no to Intesa SanPaolo's debt financing for ALBA Robot's *"modular and configurable platform to integrate … robotic technologies into electrical personal vehicles"*.

ACQUISITIONS
The ultimate sign that a bank sees a company as strategic is when the bank decides to acquire it. Whilst there have been a relatively small number of acquisitions, we've summarised many of them in the next chart - the data reflecting their size at the time of acquisition. These investments are to deliver on a variety of opportunities, ranging from fraud protection to enhanced customer product propositions.

FIG 44. KEY AI COMPANY ACQUISITIONS, 2018 - 2023

BANK	TARGET	SERVICE	DATE	FTE	EST. ANNUAL REV.	RATIONALE FOR ACQUISITION
BPCE	Rel8ed	Trade credit insurance data and analytics	2023	<25	$1M	"Will allow us to enrich our data capabilities."
Capital One	Velocity Black	Digital concierge services to customers worldwide.	2023	<30	$7.3M	"Help meet the evolving needs of our customer."
JPMorgan Chase	Aumni	Investment analytics on audited and verified closing documents.	2023	275	$40M	"Bring structure, transparency and liquidity to the historically opaque private markets"
Mastercard	Dynamic Yield	Personalisation platform and decision engine company	2021	286	$60.1M	"Meet consumer engagement demand and help brands create connections across channels"
Mastercard	Cytegic	Produce reports about cybersecurity threats and vulnerabilities	2020	<50	$2M	"To secure every transaction and instil trust in every interaction"
Goldman Sachs	HUMAN	Protect enterprises from bot attacks and fraud across digital domains	2020	500	$105M	"Help clients protect against a range of fraud types"
American Express	Radius Intelligence	Provide a marketing platform for small businesses	2019	82	$44.4M	"Offer US small businesses an efficient way to manage their cash flow digitally"
American Express	Mezi	AI-based personal travel assistant application	2018	25	$6.7M	"Create a differentiated, high-touch service for card members"
Paypal	Jetlore	Analyse and interpret consumer behaviour across merchant sites	2018	<25	$2.3M	"Expand value proposition for merchants."
Paypal	Simility	Help merchants to adjust fraud controls	2018	39	$9.6M	"Enhance payment experience for merchants and their customers"
TD	Layer 6	Broad: identify opportunities for the bank through data and AI	2018	<50	$100M	"Add innovation talent and know-how... deliver personalised experiences and automate processes."
Mastercard	Brighterion	Enhance security with analysis of transactions to improve accuracy of fraud decisions	2017	37	$16.9M	"Expand capabilities of security products with Smart Agent technology"

Source: CrunchBase, company websites, press search, Evident analysis

We will continue to monitor these approaches to investment to see what further lessons we can draw as our data continues to improve.

Conclusion

WHO IS ACTUALLY IN THIS RACE?

In our report on AI Talent we argued that the AI race was shaking out with very clear winners - largely US, with some Canadian participation. The analysis for the Innovation report represents an even starker picture.

→ In research terms, North American banks publish 6x the output of the Europeans

→ In patents, notwithstanding the regulatory differences, North American banks file 99x the number of patents as the Europeans

→ In investment terms, while European players are doubling down, North American banks still make 2x the number of AI investments as the Europeans

This does not suggest that things are going to get much better for the current also-rans. Whereas talent mapping represents the present, these indicators signpost the future.

Even within North America, we are seeing clear leaders - Capital One, RBC and JPMorgan Chase - consolidating their lead. Other banks fighting to be part of the pack of leaders like TD Bank, Wells Fargo and Bank of America will, by their very efforts, remain relevant. Elsewhere in the world, and on a smaller scale, some other banks - Commonwealth Bank of Australia and BNP Paribas, for example - are showing signs of spirit.

But clearly, too many banks don't feature significantly in this report. If this is an explicit strategy, it is a brave one. Rather more likely, AI innovation has been lumped into the "it is too hard" category, or the can that has been kicked down the road. After all, long term investments in IT, data and research talent are rarely praised when quarterly results are under scrutiny.

The danger to this approach is that - as we can see from the accelerating pace of patents being registered - the roads to the AI future are being mapped by banks prepared to put in place toll booths that will make late adoption an expensive strategy.

So what should banks learn from the leaders if they want to catch up in AI Innovation?

LESSONS FROM THE LEADERS

1. Establish an AI innovation strategy - ideally with a sense of vision for the future and a roadmap against which to prioritise investments.
2. Build an AI research team, covering applied and pure research, and give them a clear route to liaise with business leaders across the bank.
3. Publish their research, and encourage them to submit papers to leading academic AI conferences - there is a real market gap / branding opportunity for "The European AI Bank" to be created.
4. Build a couple of strong AI university relationships supporting pure research. This might perhaps be with one domestic and one globally relevant university (depending on HQ location).
5. Build out a patent strategy - especially if aspiring to operate in the US or globally.
6. Build internal incentives and foster a culture of patenting to boost focus in the AI patents space. Capital One is a good example of this.
7. Think through what the ecosystem looks like and have a proactive investment strategy to improve it.
8. Lean in to strategic investments - and test out acqui-hires as a strategy. There are experienced AI teams who can be acquired in the market.
9. Continuously benchmark the bank's position and progress against the competition.
10. Celebrate and reward even the first minor steps into AI innovation. Gathering momentum is key.

And remember, there is a cost to innovation... but if measured as the cost for survival, it is cheap.

IS GENERATIVE AI DIFFERENT?

Traditional AI Innovation is a top-down game characterised by strong leadership, aggressive focus of resources and mobilisation of intellectually elite workers: from data scientists to AI researchers. As we have seen the relationships required - whether academic, community or commercial - are typically costly, whether in management time or financial resources.

And, until late last year, making AI work in an organisation was painful – especially from the perspective of a CEO. Data had to be wrangled, experts hired at escalating cost and middle managers persuaded to be supportive. It was typically a top-down process requiring ambitious leadership and significant resources.

Making it even more challenging was that proving a return on investment (ROI) was hard. One BCG study suggested that only 10% of companies surveyed saw financial benefit from their AI investment. Boards often struggled to understand the specific opportunities of AI. Even those who did were often hard-pressed to prioritise innovation that would likely take significant time to mature - especially in the face of shareholders fretting about quarterly performance targets.

However, easy access to Generative AI tools like ChatGPT looks to have changed the weather. These are still early days but we can see three emerging impacts on AI innovation in banking.

Firstly, persuading organisations that AI is important and needs to be supported has become far easier. This is partly because everyone can see what the potential impact might be, but also because the tools to actually do things are suddenly at hand.

Secondly, shareholders no longer need to be convinced of the importance of an AI strategy. CEOs who cannot show coherent AI strategies will fast become an endangered species. Investment resources will become available. CFOs will want evidence of AI Innovation at least as much as they used to demand some evidence of ROI on complicated data projects.

Thirdly, and most importantly, GenAI allows for bottom-up innovation. Staff experimentation will create new working practices, efficiency hacks and business tooling. From marketing to coding, bank employees are busy recasting their work practices and potential levels of efficiency and effectiveness.

That most banks' initial response to ChatGPT was to ban its use by staff on grounds of data security and risk of AI "hallucination" impacting on critical business communication is a reminder of how banks tend to be run. Control and risk are not typically areas where banks believe in loosening control - typically for very good reasons.

However, those that manage to let their staff test and share their new AI hacks will have cracked possibly the biggest innovation opportunity on offer: how to become genuine learning organisations. The banks who can do that will have found an entire new form of competitive edge. That very approach would itself be the deepest form of AI-enabled innovation.