Quantum Computing in the Financial Sector

Revolutionary approaches and future perspectives under the EU Quantum Act

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bankenverband

Content

Summary	**2**
1 Introduction	**3**
2 The potential impact of quantum technologies	**4**
From classical computing to the quantum era	4
International strategies in the quantum race	5
3 Quantum technologies in the financial sector: potential, use cases, and challenges	**6**
Potential applications of quantum computing in finance	6
Key use cases	7
Existing challenges	7
Conclusion	8
4 Recommendations of the Association of German Banks	**8**

Summary

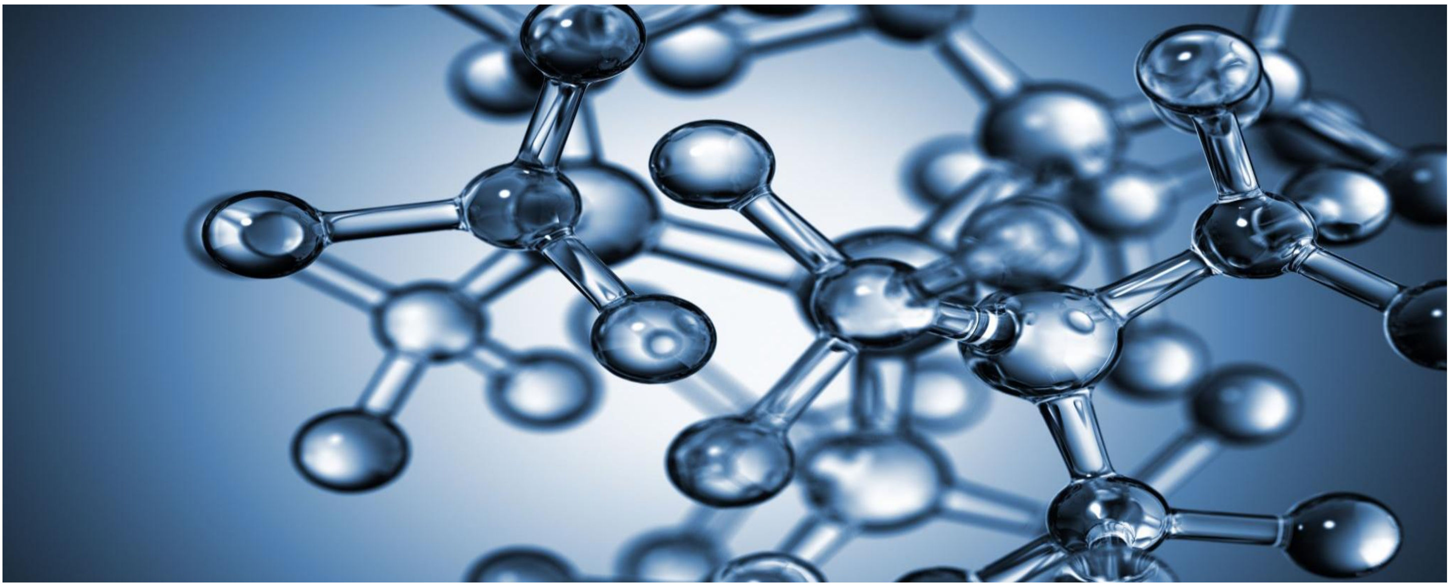
Quantum computing is regarded as a potentially groundbreaking technology whose concrete impact on the financial industry is not yet fully foreseeable. Initial research findings and pilot projects indicate that quantum algorithms could, in the long term, open up new possibilities—such as accelerating complex calculations like risk modelling, portfolio optimisation, or fraud detection. While most approaches remain in an experimental stage, early studies and tests have already demonstrated partial advantages over classical methods and delivered promising results. Nevertheless, broad practical benefits have not yet been achieved.

Before practical benefits—or scalable products—can be realised, key challenges must be overcome. These include severely limited hardware, complex integration into existing systems, and the theoretical risk of a “Q-Day,” when current encryption standards could be broken. These points underscore the need to address security aspects and technical foundations at an early stage. Against this backdrop, it is essential to closely monitor developments and establish initial prerequisites for research and infrastructure.

The Association of German Banks welcomes the European Commission’s Quantum Europe Strategy and planned Quantum Act. To ensure that Europe and its financial industry are prepared, we recommend measures to:

- Raise awareness of opportunities and risks
- Regulate in an innovation-friendly way
- Strengthen cooperation and knowledge transfer between research, start-ups, and banks
- Increase investments in infrastructure and pilot projects
- Promote development for skilled professionals and competencies

The technology is not yet market-ready, but early steps can help strengthen expertise and secure the ability to act—without underestimating existing uncertainties.



1 Introduction

"We at the Deutsche Bundesbank assume that quantum computing will transform the financial sector—and in a lasting way. [...] The greatest risk we currently see is failing to engage with quantum computing."

Joachim Wuermeling, former Executive Board Member of the Bundesbank

Quantum technologies have the potential to fundamentally transform the digital economy and our society. They will radically change both the current technological standard and the range of potential applications. These technologies enable a new form of information processing based on the principles of quantum mechanics, capable of addressing previously unsolvable problems—while drastically reducing processing times.

The Deutsche Bundesbank describes quantum technologies as a “disruptive key technology” and expects significant benefits for the financial market in particular—a sector heavily driven by computational power.

Quantum algorithms could significantly accelerate and solve complex and computation-intensive tasks such as risk modelling or portfolio optimisation with greater precision. Since speed and accuracy have a direct impact on profit and loss in the financial industry, even moderate improvements can yield substantial economic benefits. For this reason, experts consider the sector well-suited for early pilot projects and, in the long term, for productive use of quantum computing.

Due to their enormous potential, quantum technologies are regarded as one of the key technologies of the 21st century. This has triggered a global race for technological leadership, with, as yet, no clear winner. Forecasts estimate the economic value of quantum technologies—including quantum computing, quantum communication, and quantum sensing—in leading industries to reach between USD 900 billion and 2 trillion by 2035.

In July 2025, the European Commission presented the EU Quantum Strategy. Its goal is to position Europe as a leading hub for quantum technologies by 2030—through, among other things, the development of shared infrastructure and a unified industrial policy.

In addition, an EU Quantum Act has been announced for 2026. It will complement the strategy with binding measures.

We welcome this initiative and, in this paper, provide initial recommendations to support successful implementation of quantum technologies while safeguarding Europe's ability to compete on the global stage.

2 The potential impact of quantum technologies

From classical computing to the quantum era

Quantum technologies represent a fundamental paradigm shift compared to the classical computing of the last century. Quantum computers leverage the principles of quantum mechanics to perform certain calculations far more efficiently. This promises to surpass the capabilities of conventional systems and unlock new opportunities for numerous industries—including the financial sector.

Financial institutions handle highly complex tasks on a daily basis, tasks such as risk modelling, derivative valuation, portfolio optimisation, and fraud detection. These problems are computationally intensive and require precise and rapid solutions, as time and accuracy are directly linked to financial outcomes. Over decades, powerful methods based on classical computing have been developed to address these challenges—such as stochastic modelling, optimisation algorithms, and machine learning. While these approaches are well established, they are increasingly reaching their limits as data complexity and real-time requirements grow.

This is where quantum computing comes in. Quantum algorithms already exist that theoretically offer significant advantages for many of these computationally demanding problems. Initial studies show expected—and in some cases demonstrable—improvements in speed as compared to classical methods. There is the potential to overcome existing limitations and open up new solution spaces.

The financial sector is therefore considered ideally positioned to further explore the potential of quantum computing through real-world use cases and, in the medium term, to test it using pilot projects. Doing so will require technological progress as well as targeted investments in research, infrastructure, and expertise. Companies that act early can secure substantial competitive advantages—provided the predicted potential of quantum computing does become reality.

For this reason, market participants should not underestimate the first-mover advantage. Those who build expertise and capacity early could create a technological lead that would be nearly impossible to catch up to using classical approaches. Even the most advanced supercomputers face limits here—quantum computers open entirely new possibilities for data processing. Both the private sector and public authorities must prepare for this shift.

Nations that assume a leading role in quantum technologies could leverage these enormous economic benefits and dominate the next generation of industries and high-tech markets globally. Leadership in quantum technologies is a matter of technological sovereignty.

Countries that are the first to offer scalable products will force others into dependency—a dependency far more difficult and costly to overcome than that created by technologies such as artificial intelligence or cloud services. Quantum technologies pose a new challenge to Europe's sovereignty. Beyond the economic dimension, quantum technologies—in the hands of motivated actors—also represent a risk to national security. Quantum computers with sufficient computational power could, in the future, break many of today's asymmetric encryption standards and compromise the security of communication and data worldwide. Modern digital infrastructure—from banking and e-commerce to military communications—relies on asymmetric encryption, which is widely expected to be broken by quantum algorithms by the mid-2030s.

The point at which a quantum computer achieves this capability—often referred to as "Q-Day"—is considered a potential turning point for national security. Organisations that reach this milestone first would have the ability to decrypt any communication and data secured with vulnerable algorithms and exploit this advantage. This prospect has triggered a global race to develop new encryption methods resistant to quantum attacks—so-called "post-quantum cryptography."

In light of these factors, it is no surprise that governments are treating quantum technologies as a strategic priority. The race for leadership could have enormous implications for economic strength, defence capabilities, and state sovereignty.

It is therefore imperative that the EU build a comprehensive quantum economy—from research and hardware manufacturing to software development and quantum-computing-specific cloud services—and secure a global leadership position.

International strategies in the quantum race

The leading players—the USA, China, and the EU—are pursuing different strategies in their attempts to remain competitive on the global stage.

United States:
The United States is relying on a market-driven approach. The government has created an innovation-friendly environment, promoting collaboration between companies and universities, and investing in basic research. The development of scalable products is left to the private sector. This has led to a dynamic venture capital ecosystem in which private investments far exceed public spending. As a result, US tech companies such as IBM, Google, and Microsoft, as well as start-ups like IonQ, are at the forefront of global competition, primarily offering products and services tailored for enterprise use.

China:
In contrast, China's government acts as the driving and controlling force. They have declared a national goal of achieving international dominance, pursued through

state-directed measures. The government invests billions in research and implementation, coordinates all initiatives, and places strategic emphasis on military applications and quantum communication—the latter aims to enable encryption methods that even quantum computers cannot break. Estimates suggest that by 2023, state investments reached around €15 billion, making China the global leader in public funding. This approach accelerates infrastructure and expertise but limits entrepreneurial initiative.

European Union:
The EU is the third major player. Since the launch of the Quantum Flagship Initiative in 2018, significant progress has been made in research, infrastructure, and ecosystem development. Among other measures, the European Commission decided to install the first European quantum computers at six locations—including Germany, France, and Italy—in 2022. National research initiatives are increasingly coordinated to avoid redundancies and create synergies. The EU boasts excellent fundamental research but must translate this strength into economic and strategic benefits in order to achieve technological sovereignty. Unlike the US, venture capital is scarce, leaving companies heavily dependent on government funding programs.

3 Quantum technologies in the financial sector: potential, use cases, and challenges

"Financial services has been identified as one of the first industries that will benefit from quantum technologies."

Lori Beer, Global Chief Information Officer, JPMorgan Chase

Potential applications of quantum computing in finance

The financial industry faces a multitude of complex tasks traditionally solved using methods such as stochastic modelling, optimisation algorithms, and machine learning. These approaches are well established but increasingly reach their limits as data complexity and real-time requirements grow. This is precisely where quantum computing opens new perspectives.

Stochastic modelling
A key tool for valuing financial products and modelling risk is the Monte Carlo simulation. It calculates numerous possible scenarios for market or price developments to estimate probabilities and risks. While precise, this method is extremely computationally intensive. Quantum computers could theoretically accelerate this process significantly: specialised quantum algorithms promise to drastically reduce the number of required calculations.

Optimisation
Constructing an optimal portfolio is among the most demanding tasks in finance. Return, risk, and numerous other factors must be considered simultaneously. Classical methods quickly hit their limits when dealing with large datasets. Quantum algorithms offer promising prospects here: they are theoretically designed

to solve these complex problems much faster. Initial tests on small datasets show encouraging results and confirm that these approaches work.

Machine learning
Artificial intelligence is currently used for forecasting, fraud detection, and analysing large datasets. Quantum computing could make these methods more powerful in the future.
There are early concepts for quantum-assisted models and even entirely new approaches based on quantum principles. These could help simulate complex relationships in financial markets more effectively.

At present, these approaches remain largely in the research stage. Full practical benefits have not yet been achieved, but initial results are promising and underscore the significant potential to set new standards in financial technology over the long term.

Key use cases

Use case one: derivatives pricing and risk modelling
Valuing options and complex financial products requires calculating numerous scenarios to determine prices and risks. Quantum algorithms such as quantum Monte Carlo integration could significantly accelerate this process. Metrics that measure sensitivity to market changes could also be computed more efficiently using quantum methods. Furthermore, there are initial approaches for applying quantum techniques to risk indicators such as Value-at-Risk and credit risk models.

Use case two: portfolio optimisation
Optimally allocating capital across different asset classes while considering return, risk, and regulatory requirements is a highly complex optimisation problem. Specialised quantum algorithms are designed to solve such tasks faster, particularly for dynamic portfolio adjustments and index tracking.

Use case three: quantum machine learning for fraud detection and forecasting
Financial institutions currently use machine learning for credit scoring, fraud detection, and market forecasting. Quantum-based methods could make these models more powerful by reducing training time and identifying more complex patterns.

Existing challenges

Despite the enormous potential of quantum computing, numerous hurdles remain before any real advantage in practical applications can be achieved.
One of the biggest challenges lies at the interface between the classical and quantum worlds. Before a quantum computer can perform calculations, data must be converted into a format it can process—a step that is currently highly resource-intensive. After computation, results must be transformed back into a form usable by classical systems and end-users. Additional pre- and post-processing often adds complexity and can significantly reduce the theoretical speed advantage of quantum algorithms.

Moreover, current hardware limits practical use: today’s quantum computers have too few qubits and are error-prone, which severely restricts the size and complexity

of solvable problems.
In addition, each method must be carefully evaluated to determine whether quantum algorithms truly deliver an advantage. At the same time, implementation challenges must be identified and addressed systematically.

Conclusion

Quantum computing offers the financial industry the opportunity to overcome the limitations of classical methods and unlock new solution spaces. The theoretical benefits are compelling—particularly for Monte Carlo simulations, complex optimisation problems, and data-intensive machine learning applications.
However, the path to practical implementation is challenging; hardware limitations, significant resource requirements, and complex pre- and post-processing currently prevent a true end-to-end advantage. Companies that invest today in research, infrastructure, and expertise can position themselves early. Once these technological hurdles are overcome, quantum computing will not only be an efficiency driver but also a strategic competitive advantage in the financial sector.

Beyond existing pilot applications, numerous additional use cases remain to be explored and implemented. Large US banks are among the pioneers: some have maintained specialised quantum computing teams for years, developing algorithms and evaluating their use in banking. Although the technology is not yet market-ready, these institutions have already gained valuable insights. For example, a leading US bank, in collaboration with Quantinuum, developed hardware that set a new performance record. It also holds more than 20 patents for quantum-based methods and is working on solutions for portfolio optimisation, options pricing, risk analysis, and secure encryption.

European banks are also beginning to test the potential offered by quantum computing. An Italian and a French bank have been cooperating with IBM for years to explore use cases such as portfolio optimisation, risk management, and fraud detection. Beyond these, only a few other institutions in Europe are actively engaged with quantum computing—the majority still consider the topic unfamiliar. This creates the risk that the gap to leading players will widen rapidly, resulting in competitive disadvantages. Once the technology becomes market-ready, this gap will be nearly impossible to close—the lead would simply be too great.

Those who do not want to fall behind in the quantum computing race must act now. Early investments in research, infrastructure, and expertise are critical to harnessing the opportunities of this technology and remaining competitive in the long term.

4 Recommendations of the Association of German Banks

In July 2025, the European Commission adopted the Quantum Europe Strategy and announced a Quantum Act for 2026. We welcome this initiative to promote Europe's quantum industry and thereby expand and consolidate its leading role. For a successful Quantum Act that can position Europe in general—and European banks in particular—as pioneers, several premises should be taken into account:

- **Raising awareness:** Beyond the current focus on post-quantum cryptography, the potential significance of quantum technologies is still not widely recognised. It is therefore essential to sharpen awareness of possible developments and impacts in order to enable informed decisions at an early stage.

  To better engage banks and increase their involvement, policymakers can implement targeted measures. This begins with strategic communication: the potential relevance of quantum technologies for the financial sector should be made visible and publicly acknowledged. At the same time, both the European Commission and the German Federal Government should explicitly address banks as stakeholders in European and national innovation strategies and recognise the financial sector as a potentially important field for quantum applications.

- **Regulation:** According to Eurostat, fewer than 50% of all EU companies were using AI in 2024, yet we already had comprehensive legislation regulating its development and use. In 2025, there are almost no companies offering or using scalable products based on quantum technologies, but the EU is already announcing a Quantum Act. It is crucial that any regulation of quantum technology promotes innovation and creates legal certainty without putting up barriers or slowing progress. Furthermore, the EU should review the existing legal framework to identify areas that need to be updated to accommodate the use of quantum technologies and any associated risks.

- **Community and knowledge transfer:** The European Commission should significantly strengthen collaboration between research institutions, start-ups, and established companies to accelerate the development of scalable quantum computing applications.
  In sectors such as finance, it is crucial to build knowledge collectively and test initial use cases. Targeted incentives should be created to encourage participation in exchange formats, pilot projects, and cross-sector networks. Insights gained through these initiatives should be systematically documented and made accessible across the EU to foster synergies and avoid duplication of efforts.

- **Infrastructure:** The initiatives launched by the European Commission are undoubtedly an important step in the right direction. However, they are not sufficient—particularly because the availability of usable hardware is a key prerequisite for developing practical applications. These efforts must therefore be expanded and intensified across the EU. In addition to excellent research, it is critical that quantum technologies are deployed in private-sector companies to strengthen Europe's competitiveness. The European Commission should therefore invest strategically in building a robust infrastructure—especially in the production of quantum computers and in test and development centres within the EU. The goal is to provide companies with timely access to relevant hardware and software.

Furthermore, sufficient regulatory sandboxes should be established to offer companies a secure environment for experimentation and initial applications, enabling rapid and risk-free practical experience with the technology.

- **Investments:** To stimulate private investment in quantum technologies, the European Commission should establish public-private co-financing models. Public funds could be used strategically to leverage private-sector investments, provided there are concrete use cases where quantum technology can deliver substantial benefits. At the same time, barriers to entry for companies—particularly SMEs—should be lowered through financial support, such as grants for feasibility studies, pilot projects, or the development of internal expertise.
- **Talent:** The global lack of expertise in quantum technology poses a significant challenge. To address this skills gap, the EU should step up its efforts to promote the creation of new academic programmes in quantum technologies and establish retraining initiatives for professionals from other fields, enabling career changers to enter this highly complex domain. In addition, they should facilitate immigration for international experts with relevant expertise.

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