MINISTÈRE
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Trésor-Economics

No. 388 • May 2026

Direction générale du Trésor

What Issues Does the Nascent Quantum Computing Sector Raise for the French Economy?

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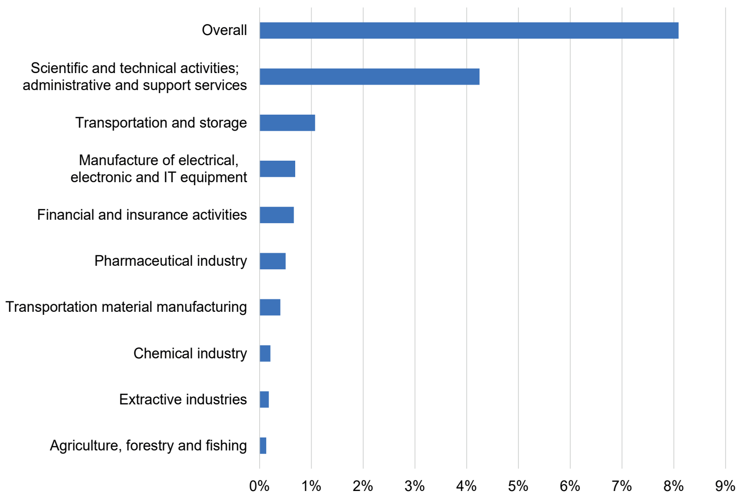
- Quantum computing is of growing interest in scientific and economic circles, with France's Michel Devoret being awarded the Nobel Prize in Physics in 2025, while Alain Aspect received the accolade in 2023.
- Quantum computers are currently still at the prototype stage, and there are considerable lingering uncertainties about the conditions of their maturity. However, the potential associated productivity gains could be significant, with foresight methodologies – that remain uncertain – indicating an eventual 8% increase in France's GDP.
- These benefits will be reaped to greater extent in some sectors than in others, particularly those in which such technology will have the most powerful applications (e.g. logistics, finance, pharmaceuticals, chemicals). The potential of quantum computing will only be realised if businesses from these sectors adopt it.
- Innovation in quantum computing is currently driven by major digital tech firms and a thriving network of start-ups. The dynamic between these stakeholders spurs competitiveness and investment. However, moves towards consolidation are already underway, with several recent acquisitions. In the long term, this trend could create barriers to entry and foreclosure effects similar to those seen in the AI computer chip sector, restricting the market's competitiveness and slowing down the technology's dissemination.
- France boasts solid assets within the quantum computing sector, including world-class laboratories, one of the strongest patent portfolios in Europe (relative to GDP) and several leading start-ups. The National Quantum Strategy, launched in January 2021 and financed under the France 2030 Investment Plan, was set up to bolster this ecosystem. There are nevertheless still major obstacles, such as a financing gap that is widening with non-European start-ups.

Potential impact of quantum computing on French GDP with a sector breakdown



Source: Oxford Economics (2025), French Treasury.

How to read this Chart: The dissemination of quantum computers across the entire transportation and storage sector would result in productivity gains that, based on this sector's share of the French economy today, raise GDP by 1.3% in the long term. Disseminating quantum computers across the entire French economy could increase GDP by 8%.

1. Quantum technologies, which are still being developed, could in time raise productivity levels in many sectors

Quantum technologies, which are based on the principles of quantum physics, allow for the development of new scenarios for use in three distinct areas of application: (i) detection, the most established of the areas (e.g. precision measurement),[1] (ii) communication (cryptography, particularly for defence) and (iii) computation. The computation area in particular aims to solve highly complex calculations quicker, calculations that cannot be solved by conventional computers (see Box 1).

With quantum computing, major productivity gains are possible in certain sectors since it optimises production processes that are currently too complex to be executed with standard computation. Such sectors include the carriage of goods (e.g. optimisation of logistical flows) or financial exchanges (e.g. optimisation of market predictions). Quantum technologies could also spur innovation, particularly in the pharmaceutical industry (e.g. discovery of new molecules).

According to foresight methodologies (e.g. that of Oxford Economics),[2] quantum computing could in time increase France's GDP by around 8% (see the Chart on the cover page). These methodologies – that should be viewed conservatively – consist of aggregating the expected productivity gains for each sector, with each sector being weighted by its own current share of the French economy. For example, this paper's authors have estimated that the dissemination of quantum computers will increase the productivity of pharmaceutical industry workers by 54%. In 2024, this sector accounted for 0.9% of France's GDP, and the gains from using quantum computers in this sector would then boost France's GDP by 0.5%.

However these gains are still only a possibility and cannot be precisely defined: the development prospects of quantum computing continue to be shrouded in uncertainty, particularly with respect to its scale-up. The current state-of-the-art is merely prototypes and computers using a limited number of qubits that cannot fully tap into the potential of quantum computing.[3] Although a scientific consensus has been reached concerning the eventual feasibility of stable quantum technologies, there is much dissent – particularly among industrial players – regarding timing, cost and the most effective technology to adopt (see Box 1).

In addition, the economic impact of quantum computing will depend on the extent and pace of its uptake by businesses. Indeed, the quantum computing market should primarily target businesses unlike generative artificial intelligence, whose rollout has been fast-tracked owing to its widespread adoption by the general public. However, quantum technologies' prospects are what effectively secure the R&D investment provided by producers, which is vital to ensuring this technology's maturation. Currently, demand for quantum computers comes from businesses that are at the cutting edge of technology.

Box 1: How do quantum bits (qubits) help speed up certain computer calculations?

Quantum computing and communication rely on the use of qubits, a quantum version of "bits", a basic unit of traditional computing. While a bit contains binary information (e.g. 1 or 0, true or false, on or off), a qubit contains other types of information thanks to the phenomena of quantum superposition[a] and entanglement[b] so that more complex calculations can be carried out. However, some aspects of quantum computing, such as data storage, are more complex than in traditional computing.

Eight avenues are primarily being explored for qubit development (see Chart 1), and represent the main technological differences between the various manufacturers.

a. According to the principle of quantum superposition (which follows on from Schrödinger's equation), an electron or photon can exist in several states at the same time.
b. Quantum entanglement refers to the influence that two quantum particles have on each other even though they are not directly linked.

(1) The scanning tunnelling microscope, which employs quantum tunnelling was for example invented in 1981.
(2) Oxford Economics (2025), "Ensuring that the UK can capture the benefits of quantum computing".
(3) The calculations are still simple: for example breaking down a number into prime factors, a key process in cryptography, cannot be done for a number larger than 21, Skosana & Tame (2021), "Demonstration of Shor's factoring algorithm for N = 21 on IBM quantum processors".

2. While the quantum technology market seems relatively competitive today, the consolidation process under way could shift the balance

2.1 Consolidation threatens to shrink the current level of competition between start-ups and large firms

Several start-ups and major digital tech firms are working to develop quantum computers. Start-ups tend to shake up the positions held by established market players, as exemplified by cutting-edge progress for certain types of qubits that are still at the basic research stage (see Chart 1). However, major firms are also contributing to innovation efforts, particularly for superconducting computers: they have considerable financing and R&D capabilities, special access to suppliers of critical raw materials and enabling technologies, and an established customer network.[4] This dynamic stimulates both investment (primarily from large firms) and innovation (partly driven by start-ups).

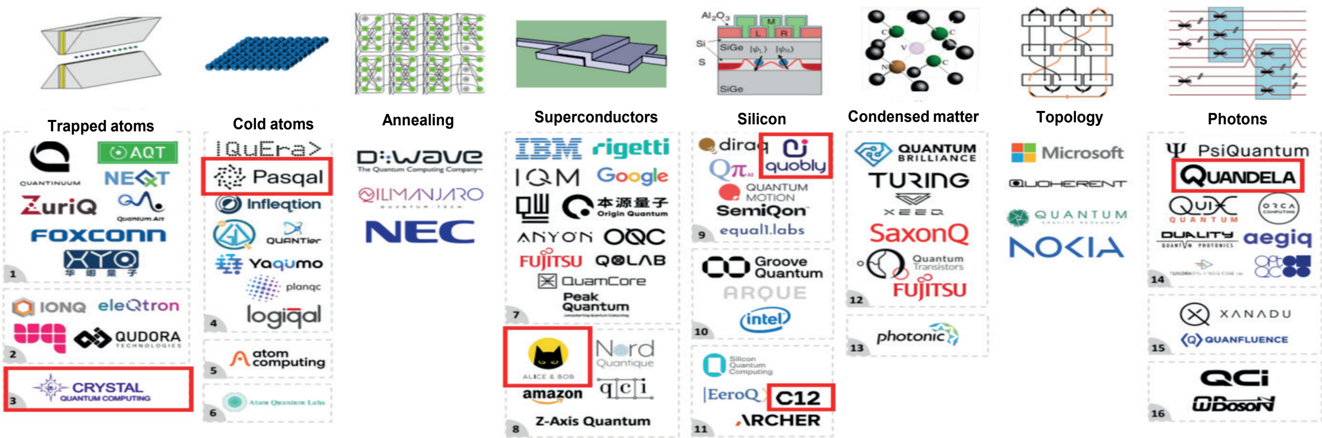
The relative balance noted up to now could be rapidly altered by acquisitions, either between start-ups[5] or by large firms. This move towards consolidation may simply be the result of market trends in which economies of scale are vital for new emerging technologies.[6] However, consolidation could quickly reinforce barriers to entry and trigger foreclosure effects particularly in technological fields, relating for example to middleware used to effectively harness such resources.[7] This could dampen the appetite of start-ups to invest and potentially prevent the emergence of the most innovative technologies.

2.2 These consolidation trends could ultimately limit related economic gains, particularly if French companies are shut out from the market

Excessively high market concentration could lead to high prices that would hamper the dissemination of quantum technologies and consequently the resulting productivity gains. For example, an increase in qubit prices of roughly 40% would cut qubit demand from user sectors by around 30%.[8] Under these circumstances, quantum technology development would only increase France's GDP by approximately 5.7% compared to 8% in perfect competition conditions (see above).

This competition issue heightens the challenges related to France's and Europe's position in relation to this technology. In addition to the issues of limiting dependency and of sovereignty associated with the civil and military applications of quantum technologies, market concentration widens the wealth gap between countries producing a given technology and the countries that simply use it: this situation, which already occurred in the digital tech sector (as highlighted by Mario Draghi in his report),[9] could occur again in the future. On the other hand, these new technologies are an opportunity to drive growth: the global quantum computing market, valued at an

Chart 1: Map of the main quantum computing producers by technology (French companies indicated by the red boxes)



Source: Olivier Ezratty, Understanding Quantum Technologies – Eighth Edition.

(4) See quantum.intel, April 2026, Quantum Computing Hits Commercial Turning Point in 2026.
(5) E.g. IonQ's acquisition of Oxford Ionics in 2025 for $1.075bn, the largest transaction of its kind in the industry.
(6) See J.-B. Auger, E. Villani (2026), "Which Competition Policy Should be Adopted to Support Growth in France and Europe?", *Trésor-Economics*, No. 381.
(7) Much like chips used to train AI; see Opinion 24-A-05 of the French Competition Authority of 28 June 2024 (in French only).
(8) Calculated by applying the price elasticity of demand (estimated at 0.7 by Q. Jiang et al. (2016), "Price Elasticity in the Enterprise Computing Resource Market") to a price increase estimated based on the increase in NVIDIA's gross margin pre- and post-2023. Calculations: French Treasury.
(9) The future of European competitiveness: Report by Mario Draghi for the European Commission (2024).

estimated €107bn,[10] would account for 3% to 4% of France's GDP. If the market structures itself around a limited number of businesses, the presence of one or more French companies would have a direct and non-negligible impact on France's economy.

3. France boasts various assets that need to be developed to protect its position on the global stage

France has an established position upstream in the value chain, maintained thanks to the country's world-leading laboratories (e.g. CEA-Leti, INRIA), and institutional arrangements between academics and industrial players set up as part of the National Quantum Strategy (under the France 2030 Investment Plan). This entire ecosystem has fostered the emergence of many start-ups, including those selected in the first phase of the PROQCIMA programme (see below) – Alice & Bob, C12, Quandela, Quobly and Pasqal. These start-ups constitute the main technological strategies adopted to help develop stable qubits.

However, certain structural obstacles in Europe could restrict the ability of start-ups to successfully move up to an industrial scale.[11] The first one is financing: up until late 2025, the three European start-ups receiving the most capital in the quantum computing sector raised €295m on average, compared to €1.7bn raised by the three top US start-ups. Several initiatives have been introduced to address this gap, particularly based on public funds such as the PROQCIMA programme (overseen by the Defence Procurement Agency, with appropriations of €500m) that finances the most pioneering French start-ups by retaining the most advanced technologies at each phase of the programme. To support private investment, public "funds of funds" programmes have been set up and private institutional investors have been solicited (e.g. the Tibi initiative) with a view to giving shape to a technology financing ecosystem, bolstered by European financing initiatives of tech champions (e.g. the European Tech Champion Initiative). The second obstacle relates to the EU market's fragmentation, particularly between the legal systems of Member States. The European Commission has proposed creating a "28th regime" (EU Inc.) in order to reduce this fragmentation, which would allow innovative European companies to operate under a single set of rules.

(10) McKinsey (2025), Quantum Technology Monitor.
(11) This difficulty is largely more apparent for deep tech businesses. See the Noyer-Kukies report (2026), "Financing Innovative Ventures in Europe. Recommendations to Close the Scaleup Financing Gap, Deepen the Savings and Investments Union and Strengthen Europe's Competitiveness".

Publisher:

Ministère de l'Économie, des Finances et de la Souveraineté industrielle, énergétique et numérique
Direction générale du Trésor
139, rue de Bercy
75575 Paris CEDEX 12

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English translation:

Centre de traduction des ministères économique et financier

Layout:

Mimose Mellia
ISSN 1962-400X
eISSN 2417-9698

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