QUANTUM COMPUTING'S POTENTIAL IMPACT ON THE GLOBAL ECONOMY[1]

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Abstract
The rapid advancement of new technologies enhances society and facilitates easier business, education, collaboration, communication, and other aspects of people's life. Although it is still in its early phases of development, quantum computing, which is strongly anchored in quantum mechanics concepts, has immense potential to significantly impact the development of numerous fields. Quantum computers have demonstrated that they can perform some tasks tenfold quicker than traditional computers, and can solves problems that are too complicated for traditional computation by leveraging quantum physics' distinctive features. This is due to the fact that quantum computing uses the qubit as the fundamental unit of information rather than the traditional bit. The primary feature of this alternative system is that it allows for the coherent superposition of ones and zeros, the binary digits that underpin all computing. This technology has the potential to alter businesses by addressing complex, intractable problems that are now beyond the capabilities of traditional high-performance computers. The development of quantum computing is increasingly showing the potential to revolutionize many fields in the near future and greatly affect the global economy. The ability of this technology to impact the world economy is represented not only in far greater speeds, but also in precision and efficiency, allowing industries to benefit from complicated simulations and optimizations.
Keywords: Quantum computing, Global economy, Qubit, New technology

INTRODUCTION

Modern technologies are increasingly prevailing and suppressing traditional ones (Baltezarevic et al., 2019). In terms of technological advancement, quantum computing is a leading field. Because of its inherent parallelism, which is made possible by quantum mechanical features like superposition and entanglement, it promises a considerable speedup over classical processing in some workloads (Bennett & DiVincenzo, 2000). By 2040, the quantum industry is predicted to employ more than 600,000 people as a result of the technology's growth into other sectors where ground-breaking innovations can be valuable (He & He, 2021).
Subatomic particles, including electrons and photons, are used in quantum computing. These particles can exist in more than one state (i.e., 1 and 0) simultaneously thanks to quantum bits, or qubits. Today's classical computers encode information in bits using a binary stream of electrical impulses (1 and 0). When contrasted with quantum computing, this limits their processing capacity (Frankenfield, 2023). Additionally, quantum is more in sync with nature. The building blocks of the cosmos are molecules, which are made up of several atoms joined by electrons that are inherent to each one.

[1] The paper presents findings of a study developed as a part of the research project “Serbia and challenges in international relations in 2024”, financed by the Ministry of Science, Technological Development and Innovation of the Republic of Serbia, and conducted by Institute of International Politics and Economics, Belgrade during year 2024.

Quantum particles mimic the way these electrons essentially inhabit two states at once, which presents applications for natural and material sciences by anticipating how substances behave under corrosion or how medications interact with the human body. Conventional manufacturing relies on deliberate guesswork and trial and error to achieve breakthroughs; quantum, by reflecting nature, should enable intentional design of advancements (Campbell, 2023).

The application of quantum technology has the potential to significantly alter numerous sectors and international business networks. Although still in its infancy, quantum computers make use of the concepts of quantum mechanics. Nonetheless, they have the ability to resolve issues that traditional computers are presently unable to resolve, especially in the fields of quantum system simulation and cryptography (Vasiliu-Feltes, 2023). The goal of this field of study is to create new technologies and methodologies that could lead to substantial innovation and change in a variety of industries, with broad ramifications for society, the economy, and geopolitics (Ibid). While these programs prioritize research and hardware technology development, they also highlight the value of complete ecosystems. These ecosystems will bring together the whole value chain, including hardware and software solution providers, investors, and, most importantly, industry, which is critical for moving forward with high-value use cases that can be commercialized (Filipp & Leibinger, 2021).

Currently, seventeen countries, including the United States, China, Russia, and the United Kingdom, have some type of national plan or strategy to assist quantum technology research and development. In twelve countries, including Denmark, Spain, the UAE, and Canada, governments and non-profit foundations have invested heavily in quantum-related research and technology development (*Kung & Fancy*, 2021). The European Union is launching a number of initiatives to develop appealing ecosystems and markets for quantum technologies (Federal Ministry of Economic Affairs and Energy, 2021).

QUANTUM COMPUTING: THE ROLE IN THE GLOBAL ECONOMY

In recent years, quantum computing has emerged as a potentially revolutionary computing technology. Quantum computing uses quantum physics concepts to analyze data more efficiently than traditional computing methods. The speed and capabilities of such advanced computing greatly exceed those of traditional computing, opening the door to a wide range of potential applications, including economic analysis (Cao et al., 2019). The capacity of quantum computers to process massive volumes of data and computations can provide enterprises with a competitive advantage. Businesses have a huge chance to tackle complicated challenges through the significant acceleration of data-driven decision-making provided by quantum computing (Kwok, 2023).

An International Data Corp. report projects that the global quantum computing market will reach $8.6 billion by 2027 (Campbell, 2023). Quantifying quantum venture capital and private equity investments' compound annual growth rate (CAGR) is challenging, but the most recent report estimates that the global quantum computing market will reach a size of approximately $5300 million by 2030, growing at a CAGR of roughly 31% between 2022 and 2030 (Vasiliu-Feltes, 2023). Given all of the recent technological investments, the effects of quantum will be significant. Quantum computing is a powerful accelerator for the digital economy and has the potential to change a number of industries. In domains like cryptography, which is essential for safe digital transactions and communications in many sectors, quantum computing can offer substantial benefits (Ibid).

Quantum superposition and quantum entanglement are two examples of quantum mechanical phenomena that are employed by computers to manipulate data. The study of quantum computation is concerned with creating computer technology that is based on the ideas of quantum theory (Gill et al., 2022). Quantity of data is expressed in bits in traditional computing, but qubits are used to quantify data capacity in quantum computing. Quantum physics is used to perform operations on data and to represent data (and data structures) using the quantum properties of particles. This is the core idea behind quantum computing. That being said, creating a new logic framework based on quantum principles is a prerequisite for creating a computer that is quantum-based (Zidan et al., 2021). Superconducting loops (microwave radiation) and ions floating in ion traps within electromagnetic fields (lasers) are examples of how quantum mechanics' equations are applied in quantum computing (Jackson & McAdams, 2021). Problem-solving by quantum computing makes use of quantum behavior. Organizations are assisted and encouraged to tackle issues that are impractically difficult for traditional computers to handle by virtue of this quantum advantage. Accordingly, a wide range of computational activities can be performed using universal quantum computing using huge fault-tolerant quantum computers or hybrid classical/quantum computers (Ibid).

The difficulty of creating the hardware itself exacerbates the issue. Quantum bits, or qubits, are quantum binary numbers that are used by quantum computers to store data. These bits can be created utilizing a variety of technologies, including as optical traps, superconducting rings, and light photons (Brooks, 2023). While certain technologies must be cooled almost to the absolute zero, others can function at ambient temperature. While Hensinger's design calls for a device the size of a football field, other versions might find their way into automobiles. Even the best way to quantify the performance of quantum computers is a topic of debate among researchers (Ibid). Traditional algorithms cannot be executed by quantum computers since qubits have probabilistic values. It is necessary to create new algorithms especially for quantum computing in order to use them (Dungey et al., 2022). These algorithms, also known as quantum algorithms, are created in a manner akin to circuit diagrams, with quantum logic gates being used to compute data step-by-step. Building these algorithms is quite challenging, and the main obstacle is that the algorithm's result must be deterministic rather than undefined or uncertain (Ibid).

Because the advantages of having a single computer that can outperform several supercomputers are so great, governments, businesses, the scientific community, and the technology sector are spending billions of dollars developing and utilizing quantum computing (McGregor, 2023). It is difficult to keep a qubit stable or long-lived in a superposition state; it may only last a few milliseconds or microseconds. However, research in this field is still in its early stages. AI has the potential to both enhance the capabilities and performance of quantum computers and be enhanced by them (Ibid). This technology is useful in many aspects of contemporary life, and there is mounting evidence that it will also strengthen the prospects for the world economy, as well (Baltezarević, 2023). There are three specific areas that will benefit from quantum computing as it relates to the global economy. First, there's the gain in productivity from quantum-enhanced generative artificial intelligence, which can predict market trends, optimize supply chains, and automate repetitive jobs to expedite company processes. Gains in efficiency across all industries and economic growth are possible outcomes of this higher productivity (Zohuri, 2023). Second, new industries are going to arise. These technologies coming together has the potential to create whole new industries. AI-driven quantum algorithms and quantum machine learning can open doors for start-ups and creative companies, resulting in the creation of jobs and economic diversification. Last but not least, global competitiveness.

A competitive edge in the global economy is probably in store for nations and businesses who invest in and use generative artificial intelligence and quantum computing. This may result in a change in the global balance of economic power and influence (Ibid).

Organizations struggle to preserve what has been achieved while respecting every change in global society. The need to adapt in accordance with rapid changes is imperative for survival in society (Milutinović et al., 2022). However, in the process of digital transformation, it is not recommended to rely exclusively on technology, because the coexistence of people and machines brings better results in terms of company performance (Papakonstantinidis et al., 2021). One of the first sectors to gain from quantum computing is predicted to be finance, with the potential for long-term disruption in this field, especially in the domain of machine learning-solvable financial applications. But the emergence of quantum computing also threatens established cryptography methods, which are necessary for safe operations in a number of technologies, including blockchain, 5G, AI, and the Internet of Things (Typeset, 2024). The financial sector would undergo a profound transformation as a result of quantum computing, notably in the areas of credit sorting, arbitrage, stock valuations, and portfolio management (Hassija et al., 2020). A highly effective and target-driven recommender system and ads with high conversion rates will also be affected, so impacting the marketing discipline (Mo et al., 2021).

CONCLUSION

With its enormous potential, quantum computing looks certain to play a major role in determining the direction of global technology and economics. But, as this technology is still in its infancy and faces numerous obstacles (most of which are hardware-related), it is imperative to maintain a reasonable level of optimism for the time being. Also, there are still not enough scientific papers in the scientific literature (at least as far as the impact of quantum computing on the global economy is concerned), but over time, scientific studies will appear that will more precisely indicate the potential benefits of the synergy of these two areas. In any case, the first results are fascinating. And the best evidence is the initiatives of major world powers (such as United States, China, Russia, and the United Kingdom) to join the race of developing this promising technology in a timely manner. It can be said that quantum computing also has a geopolitical role.

A qubit, which is the quantum mechanical equivalent of a classical bit, reflects the power of a quantum computer. Unlike ordinary binary bits, qubits are not restricted to just two states. Because it can exist in several states, the quantum computer's processing power is exponential. A qubit may carry out several times as many calculations at once thanks to the superposition effect. When this technology reaches its full potential, it will have a significant impact on a number of fields, including big data, logistics, healthcare, artificial intelligence, cryptography, finance, and many others. To enable people to work in this fascinating and quickly changing industry, the government, educational institutions, and businesses will need to make investments in workforce development and education initiatives. Professionals with the necessary skills will be in high demand as the quantum sector grows.

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