Quantum Strategy Institute

Export Controls & Quantum Technologies

Petra Söderling, Head of Government and Consortium Relations at the Quantum Strategy Institute (QSI).

Petra Söderling has over 25 years of experience in the technology industry, having held key positions in standardization, open source, research, and product management at Nokia. She has an MBA from Helsinki University of Technology, and executive education from Harvard Business School and Stanford University.

Being Finnish-American, she has been instrumental in ramping up trans-Atlantic relationships in quantum since 2020. She is also a key contributor to EU's quantum strategy, financing, standardization, and international relations.

Petra Söderling is the author of Government and Innovation - the Economic Developer's Guide to our Future.

Brian Lenahan, Brian Lenahan is Founder & Chair of the Quantum Strategy Institute and the author of seven published books on quantum technologies and artificial intelligence.

He is a recognized speaker and moderator at conferences around the world and a global consultant on the strategy of road mapping quantum and AI tech adoption. He is the author of Quantum's Business Substack, enjoyed by thousands of readers in over 90 countries.

Brian is a three-time LinkedIn Quantum Top Voice. He leverages all of his media platforms to augment the work of QSI in accelerating the adoption of quantum technologies worldwide.

About QSI: QSI provides industry participants with ongoing insights into the progress in the field of quantum technologies through research, social media, and conference presentations. You can find more information about QSI on our website.

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1. Export Controls & Quantum Technologies

Nations worldwide are investing heavily in quantum research and development (R&D), recognizing its strategic importance for national security and economic competitiveness. As governments recognize the critical nature of these technologies, companies, large and small, have begun to develop quantum products and services. When the government sees an emerging technology as a resource and opportunity, it lessens the risk for private companies to do the same.

As the field advances, policy makers are growing increasingly worried that the technology might, in the hands of a bad actor, be a threat to their national security. Additionally, sovereign nations are always looking after their economic interests and look for ways to stay ahead of the curve when it comes to creating and implementing emerging technologies.

One of the ways to regulate the international dissemination of quantum technologies are export controls. These controls are designed to prevent adversaries from accessing sensitive technologies while ensuring that domestic industries maintain their competitive edge.

While export controls serve critical security interests, they also may pose challenges for the global quantum technology ecosystem. This QSI paper explores the implications of export controls on the quantum sector, including their effects on innovation, international collaboration, market access, and geopolitical competition.

Export controls on quantum technologies in current day are driven by several key factors:

- National Security Concerns: Quantum computing and quantum cryptography have the potential to break conventional encryption, making them crucial to cybersecurity and intelligence operations. Governments seek to prevent adversaries from acquiring quantum capabilities that could undermine national security.

- Strategic Economic Interests: Leading nations or regions in quantum research, such as the United States, China, and the European Union, aim to maintain their technological superiority by restricting foreign access to their key quantum assets.

- Non-Proliferation Objectives: Quantum sensors and other high-precision quantum-based technologies have military applications, such as in submarine detection and navigation. Export controls are used to prevent the proliferation of these technologies to potentially hostile entities.

While policy makers have incentives to put restrictions in place, these controls may have unintended consequences. One of the most significant consequences of export controls is their potential effect on innovation and scientific collaboration: Quantum research is inherently international, with scientists and institutions collaborating across borders. Export controls may hinder these collaborations, making it difficult for researchers to share knowledge, access critical materials, or jointly develop technologies.

Many quantum research labs rely on international talent. Stricter export controls could affect talent mobility and discourage skilled researchers from working in certain countries. This may limit the flow of expertise and slow progress.

Additionally, open-source quantum software frameworks play a crucial role in advancing the field. If export controls are applied too broadly, they may stifle open-source contributions and slow the development of quantum algorithms.

2. The Wassenaar Arrangement

Governments may decide to impose export controls on a certain technology, or groups of technologies against one or several countries, or they can join an export controls organisation or treaty, such as the Wassenaar Arrangement on Export Controls for Conventional Arms and Dual-Use Goods and Technologies.

As a dual use technology - a technology that can be used both for civilian and/or military purposes - quantum falls under The Wassenaar Arrangement, established on 12 July 1996, in Wassenaar, Netherlands. It was established to contribute to regional and international security and stability by promoting transparency and greater responsibility in transfers of conventional arms and dual-use goods and technologies, thus preventing destabilizing accumulations. Participating states seek, through their national policies, to ensure that transfers of these items do not contribute to the development or enhancement of military capabilities which undermine these goals and are not diverted to support such capabilities.[1]

In order to be a member of the Wassenaar Arrangement, countries need to meet these universal and non-discriminatory criteria:

- Produce/export arms or associated dual-use goods and technologies
- Implement national policies that do not permit the sale of arms or sensitive dual-use items to countries whose behavior is a cause for concern
- Adhere to international non-proliferation norms and guidelines
- Implement fully effective export controls

As a member, each country is obligated to maintain rigorous national export control systems which mirror closely the requirements of the former Coordinating Committee for Multilateral Export Controls (COCOM).[2] This was an arrangement that ran from 1949 until 1994, coordinating controls on exports from Western Bloc countries to the Soviet Union and its allies. Members are also expected to be members of or be acting in accordance with the Treaty on the Non-Proliferation of Nuclear Weapons (NPT), Missile Technology Control Regime (MTCR), Chemical Weapons Convention (CWC), and the UN Register of Conventional Arms.[3]

2.1 How the US Became Dominant in Technology

The United States, particularly post-World War II, leveraged a combination of government investment and venture capital, public-private partnerships, talent attraction, standard setting and military civilian dual use technology to gain dominance in the tech industry.

Massive investments in R&D during the Cold War, particularly via DARPA (Defense Advanced Research Projects Agency) into projects like ARPANET laid the foundation for the internet, while funding for microelectronics research spurred the semiconductor industry. The US used export controls under frameworks like the Wassenaar Arrangement and the Export Administration Regulations (EAR) to restrict sensitive technologies (e.g., advanced semiconductors) from adversaries like the Soviet Union, and later

China. This protected US intellectual property and maintained a technological edge, ensuring military superiority and economic benefits for US firms like Intel and IBM.

Channeling government funding into universities and private companies (e.g., Bell Labs) helped the US create an innovation ecosystem where controlled access to technology gave domestic firms a head start in global markets. The US attracted global talent through visa programs like H-1B, drawing scientists and engineers from Europe, Asia, and beyond to Silicon Valley. This brain trust fueled innovation at companies like Apple, Google, and Microsoft.

The US fostered a risk-tolerant venture capital ecosystem, funding startups like Fairchild Semiconductor and Cisco. Tax incentives and deregulation encouraged entrepreneurship. US companies and institutions shaped global tech standards (e.g., TCP/IP for the internet, IEEE standards for electronics). This gave US firms a first-mover advantage in markets adopting these standards.

The US also integrated military and civilian tech development, with defense contracts driving innovations like GPS and microchips, which later found commercial applications.

2.2 "Wassenaar minus one"

The Wassenaar Arrangement has 42 participating states, including Russia.

Efforts have been made collaboratively to determine which items should fall under export restrictions for dual-use technologies and military-grade equipment. Typically, once consensus is reached, each member country integrates these controls into their national regulations. Although Russia is a participant in the Wassenaar Arrangement, since its renewed aggression against Ukraine in 2022, it has blocked proposed additions to these control lists, along with support from a few other states. These proposals have included certain quantum technologies.

Between 2022 and 2024 several states have made unilateral agreements outside of the Wassenaar Arrangement to legislate export controls and attempted to bring them into the agreement. One of these proposals was by Spain to add "quantum computers containing more than 34 qubits and error rates below a certain controlled NOT gate error threshold", along with "restrictions for quantum computers with more qubits and higher error rates, and cryo-computing technologies". These restrictions were not accepted into the Wassenaar Arrangement due to the objection by the Russian delegation.

Due to the resulting impasse, a coalition of like-minded countries has taken independent steps, informally dubbed "Wassenaar Minus One," to align and update their export controls outside the formal framework. In 2024, several countries announced their lists of quantum technologies that they deemed under export controls, including the UK in March, Canada in July, 2024, the U.S. in September of 2024. Many other countries have since announced similar lists of quantum technologies that their national legislations would treat under their export control regulations. These announcements have in essence created a "Wassenaar minus one" for the quantum industry.

A November 2024 article in the *Inside Quantum Technology*[4] publication concludes that:

- *"The new export controls provide a roadmap for companies in emerging tech, including quantum tech, to know how new rules will be implemented. Fortunately, the rules accommodate the realities of global commerce and acknowledge that adjusting to them will take time. Mr. Friedman and Mr. Stimers say that people generally consider the rules reasonable, recognizing that quantum tech has security implications. The rules could've been worse, with no grandfathering, no grace period, and more restrictions, but at least the dice have been put away and exporters know what's coming."*

3. Market Access & Economic Implications

While the quantum industry greeted these new export controls with a relief, "it could've been worse", export controls do shape the economic landscape. Companies developing quantum technologies may face restrictions on selling their products or licensing their intellectual property to foreign entities, limiting their revenue potential and slowing market adoption.

A 2022 survey among the members of the QED-C, the U.S. quantum industry alliance, found that "US policy options that were considered very detrimental included more severe import/export tariffs, strengthened deemed export policies, and more stringent goods and services export control regulations."

As said by one company providing quantum enabling technologies, *"the playing field is not level for Europeans and U.S. based companies when it comes to selling our products to China*". Companies from countries who did not sign these export controls into law, have a regulative advantage over companies from countries who did.

There could also be barriers to commercialization. Quantum technologies require specialized components, not always readily available in your home country. Export controls may disrupt supply chains, making it difficult for companies to source critical materials from international suppliers. A company we spoke to, creating quantum solutions in the life science space, fears that end users in healthcare and pharma may prioritise other, less restricted technologies when it comes to co-development, joint R&D projects, and shared lab equipment, for example.

There is also an impact on access to private investment. Startups in the quantum sector often rely on venture capital and strategic partnerships for growth. If export controls limit access to global markets, and create geopolitical silos, investors may be more in favor of other, less restricted DeepTech areas, leading to a slowdown in quantum innovation.

4. Geopolitical Competition and Technological Decoupling

In 2015 China announced the “Made in China 2025” plan, an industrial strategy to further develop the manufacturing industry in the People’s Republic of China. For the west, this would include the idea that Chinese companies would no longer be subcontractors and suppliers to western manufacturers but would compete with them head-to-head in the global markets.

With Russia sanctioned because of its 2014 and 2022 attacks on Ukraine, and concerns rising over China becoming a dominant superpower, many countries are increasingly careful with who they trade DeepTech, dual use technology with.

In our interviews with the quantum industry, some industry associations grouped countries roughly in three buckets; the A bucket, friendly allies who we trade with, the B bucket, countries where we may buy from or sell to if needed, case by case, and the C bucket, the enemies who we keep away from our quantum technologies. A representative from an Eastern European country who would fall under bucket ‘B’, felt this is a big perception issue for them. Small countries are dependent on international trade, and even if there would be no problem with a company or a technology from this country, the perception may turn away business partners.

Many of the trusted countries, bucket A, were among the 12 nations launching the Entanglement Exchange in 2022. The Entanglement Exchange is a portal for highlighting international exchange opportunities for students, postdocs, and researchers in quantum information science (QIS).

Separately, to date, the U.S. has signed bilateral quantum collaboration statements with 11 countries; Japan, Finland, UK, Australia, Sweden, Denmark, Switzerland, France, the Netherlands, South Korea, and Germany.[5] The American approach to negotiate one-on-one is not making all of their allies happy, for example the European Union would no doubt prefer that these quantum conversations would be held between the EU and the U.S.

The Australia, United Kingdom, United States (AUKUS) Enhanced Trilateral Security Partnership also negotiates export controls, most recent revisions in 2024. These revisions[6] eased export controls among Australia, the U.S., and the U.K., facilitating faster development and deployment of quantum technologies in defense applications.[7]

In 2023, NATO published its first-ever Quantum Technologies Strategy detailing its ambition to become “a quantum-ready alliance” and 22 Allies are currently part of NATO’s quantum community.[8] The objective of the NATO Transatlantic Quantum Community is to strategically engage with government, industry and academia from across our innovation ecosystems.

There are many strong quantum technology countries, political and military allies of the U.S. that have not been included in these private clubs and exclusivity statements. The current US administration has introduced additional uncertainty to how much allies are willing to create dependencies between theirs, and the American dual use technologies. Multiple countries are finding new trading partners without the U.S.[9] and with enough time and enough trade, trading partners tend to become military allies.

Quantum is not alone in this heightened state of alertness. As countries re-evaluate their national security priorities and implement restrictive policies, there is a risk of a technology arms race, where nations prioritize secrecy over collaboration, leading to redundant research efforts which may slow global progress.

The European quantum industry alliance, QuIC, also sees benefits in export controls. In their recent 2025 white paper[10] the European industry is calling for strategic autonomy. Their report recommends building "control points" in the global quantum supply chain—nodes where European firms produce key inputs that others depend on. This not only allows for Made in Europe quantum products but provides "geoeconomic leverage."[11]

5. Recommendations

To mitigate the negative impact of export controls on quantum technology while ensuring national security, policymakers should seek to adopt a balanced approach.

Rather than broad restrictions, export controls should focus on specific high-risk technologies while allowing collaboration in foundational research and work together to establish global standards and guidelines for quantum technology exports to prevent unnecessary barriers to innovation.

6. Summary

Export controls on quantum technologies are neither inherently good nor bad. They are a policy tool, and like any tool, their impact depends on how they're used.

Strong, coordinated regions can leverage export controls to their economic and military advantage, shaping standards and protecting strategic interests. Meanwhile, small or politically isolated countries often lose out, excluded from key partnerships and markets.

However, the future of quantum is unlikely to mirror the "winner-takes-all" dynamic of today's U.S.-dominated tech landscape. Instead, many countries have the opportunity to follow the U.S. playbook by combining public investment, talent attraction, dual-use innovation, and export strategy to build competitive quantum ecosystems of their own.

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