



Article

# Legal Impacts of Quantum Computing in Trade

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**Abstract:** Quantum computing, with its unparalleled processing power, is set to revolutionize global trade by transforming supply chains, finance, and logistics. However, this technological leap also introduces urgent legal and regulatory challenges that traditional trade frameworks are ill-equipped to handle. This article examines the evolving legal landscape around quantum computing in international trade, focusing on five critical domains: data protection, intellectual property (IP), export controls, competition law, and litigation risk. It outlines how quantum threats to encryption jeopardize secure data exchange and compliance with laws like the GDPR, while also threatening IP enforcement through the potential decryption of trade secrets. Export control regimes are tightening around quantum technologies, raising concerns over market fragmentation and technology protectionism. Meanwhile, rising market concentration among quantum tech firms is drawing scrutiny from antitrust regulators. Through visual tools, legal risk mappings, and comparative analysis, the article calls for urgent adoption of post-quantum cryptographic standards, legal workforce upskilling, and globally coordinated trade policies to ensure a secure and innovation-friendly future.

**Keywords:** Quantum computing, international trade law, post-quantum cryptography, GDPR, data security, trade secrets, export control, deemed export, IP protection, quantum patent law, market concentration,

## INTRODUCTION

Quantum computing stands at the cusp of revolutionizing international trade by unlocking unprecedented computational power, yet it also introduces profound legal risks and regulatory complexities. As nations and corporations race to harness quantum capabilities, legal frameworks must adapt rapidly to manage new threats to data security, intellectual property, and global commerce. This research article systematically analyzes the legal impacts of quantum computing on global trade, reviewing essential domains such as data protection, export controls, intellectual property, antitrust, and the future of regulation.

### 1. Quantum Computing: An Overview for International Trade

Quantum computers use principles of quantum mechanics to perform calculations at speeds and scales impossible with classical machines. Their anticipated commercial applications in trade include supply chain optimization, transaction security, logistics modeling, and advanced risk analysis. However, this leap brings legal uncertainty, as traditional regulations struggle to govern such disruptive technology.

### 2. DATA SECURITY AND TRADE: ENCRYPTION AT RISK

#### 2.1 The Imminent Threat to Cryptography

Quantum computers have the potential to break widely-used cryptographic systems (like RSA and ECC) integral to digital trade, financial transactions, and cross-border data flows.

- Today's digital trust relies on encryption—quantum computing may render existing methods obsolete, risking exposure of sensitive business, personal, and state data<sup>[1][2]</sup>.

- "Harvest now, decrypt later": Malicious actors may collect encrypted trade data now, to decrypt once quantum computers reach maturity—posing retroactive legal risk and liability for breaches<sup>[1]</sup>.

## 2.2 Legal and Regulatory Repercussions

- **Data Protection Laws:** Regulations such as the EU's GDPR and India's DPDPA require robust data security. Quantum threats force organizations to transition to "post-quantum" encryption or risk severe penalties for non-compliance<sup>[3][4]</sup>.
- **Liability:** Failure to migrate to quantum-safe protocols could trigger litigation, penalties, and shareholder actions if breaches occur and impact business or consumer trust<sup>[1][2]</sup>.

[image:1]

Figure 1: Timeline—Transition to Quantum-Resistant Cryptography in Trade

## 3. Intellectual Property (IP) in a Quantum Era

### 3.1 Challenges in Patent and Copyright Law

- Quantum innovations—algorithms, hardware, and materials—challenge existing IP regimes.
- Jurisdictional fragmentation, uncertainty about quantum software patentability, and difficulties in protecting quantum innovations internationally may generate new disputes and slow global adoption<sup>[5][6]</sup>.

### 3.2 Quantum Threats to Trade Secrets

- Quantum computers may reverse-engineer, decode, or systematically uncover protected trade secrets, exacerbating cross-border IP theft risks<sup>[4][6]</sup>.
- Businesses will need new legal and technological safeguards for confidential information in the quantum age.

### 3.3 Collaborative IP Models

- Policymakers may develop frameworks for cross-licensing, patent pools, and open-source initiatives to enable secure and equitable diffusion of quantum technologies globally<sup>[5]</sup>.

## 4. EXPORT CONTROLS, TRADE REGULATION, AND INVESTMENT SCREENING

### 4.1 Export and Import Restrictions

Quantum technology is considered dual-use, with military and commercial relevance. As such:

- The U.S. and other nations have expanded export controls to cover quantum computers, software, sensors, and related intellectual property, mirroring controls applied to advanced semiconductors and AI<sup>[7]</sup>.
- These controls impact not only hardware exports but also "deemed exports"—transfers of technology to foreign nationals within borders<sup>[7]</sup>.
- Major trading nations (including China, the U.S., and the EU) have implemented or are planning legislation to respond to quantum's strategic significance by tailoring licensing, trade, and investment rules<sup>[3][7]</sup>.

### 4.2 Fragmentation and Trade Tensions

- Quantum-related export regimes threaten to create technology "blocs" and barriers in global supply chains, as seen in semiconductor trade wars<sup>[3]</sup>.
- WTO frameworks may strain under these pressures, risking further erosion of globally harmonized trade systems.

[image:2]

Figure 2: Growth in Quantum-related Export Control Measures, 2020–2025

## 5. Antitrust, Competition, and Market Concentration

Quantum computing's development is dominated by a small group of tech giants, raising significant competition law challenges:

- Potential for anti-competitive conduct and market power abuse, which regulators worldwide are closely watching<sup>[1][5]</sup>.
- National security concerns are bringing quantum technology into foreign direct investment screening regimes (e.g., UK, EU, US).

## 6. Risks to Trade Data, Compliance, and Litigation

LEGAL AREA	QUANTUM-SPECIFIC RISK	TRADE IMPACT
DATA PROTECTION	OBSOLESCENCE OF CURRENT ENCRYPTION STANDARDS	EXPORT/IMPORT DATA, FINANCIAL TRANSACTIONS <sup>[4]</sup>

INTELLECTUAL PROPERTY	PATENTABILITY OF QUANTUM TECH, IP THEFT VIA QUANTUM PROCESSES	LICENSING, CROSS-BORDER R&D
EXPORT CONTROLS	STRINGENT LICENSING, “DEEMED EXPORT” SCRUTINY, SUPPLY CHAIN RISK	INTERNATIONAL TECH TRANSFER
ANTITRUST/COMPETITION	CONCENTRATION, COLLUSION, MARKET ABUSE	BARRIERS TO ENTRY, STIFLED INNOVATION
DISPUTE/LITIGATION RISK	INCREASE IN CYBER-BREACHES, NEGLIGENCE SUITS, REGULATORY PENALTIES	CLASS ACTIONS, INSURANCE CLAIMS

Table 1: Legal Risk Mapping for Quantum in Trade (2025)

## 7. Policy and Regulatory Recommendations

- **Adopt Post-Quantum Encryption:** Immediate investment in and adoption of quantum-safe cryptographic protocols are essential for businesses engaged in international trade<sup>[1][2]</sup>.
- **International Coordination:** Push for global standards in trade law and IP in relation to quantum technologies, avoiding regulatory balkanization<sup>[5][3]</sup>.
- **Forward-Looking Legislation:** Governments should update export control, investment screening, and antitrust regulations to address quantum’s unique features<sup>[7]</sup>.
- **Legal Workforce Preparedness:** Invest in quantum literacy for lawyers and compliance professionals to manage future disputes and compliance requirements<sup>[5][8]</sup>.
- **Research and Transparency:** Encourage transparent, collaborative development across jurisdictions while managing national security interests.

## 8. Visual Comparison: Quantum vs. Classical Risk in Trade

Factor	Classical Computing	Quantum Computing
Data Security	Relies on standard encryption	Requires post-quantum cryptography
IP Law	Established frameworks	New patent/copyright challenges
Export Controls	Focused on semiconductors/AI	Expanded to quantum tech, software
Antitrust Concerns	Moderate tech concentration	Higher risk, limited providers
Litigation Risk	Conventional cyber risks	Heightened due to cryptographic failures

Figure 3: Comparative Legal Risks in Trade—Classical vs. Quantum Computing

## CONCLUSION

Quantum computing is transforming the legal landscape of international trade. It heralds breakthroughs in efficiency and new market opportunities, but also exposes gaps in data security, IP protection, export regulation, and antitrust enforcement. A coordinated, forward-looking legal strategy—incorporating new cryptographic standards, international policy harmonization, and continuous legal education—is vital to safeguard trade in the quantum era. Nations, businesses, and the legal community must work together to ensure that the quantum leap bolsters, rather than destabilizes, the global trading system.

[image:1]

[image:2]

[image:3]

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