Science & Technology · GS - III

Analyse how export controls on advanced semiconductor technologies are reshaping global technological competition and supply-chain security.

EXAM YEAR	PAPER	SUBJECT
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MARKS	WORD LIMIT
15	~250 words

Answer Hint

Semiconductor geopolitics, national security, AI ecosystem, technology denial, supply-chain resilience, strategic autonomy, international cooperation

Model Answer

Introduction

Advanced semiconductors are critical inputs for artificial intelligence, supercomputing, telecommunications and modern defence systems. Their strategic importance has transformed semiconductor trade into an instrument of geopolitical competition.

Impact of Semiconductor Export Controls

1. **Strategic Technology Denial:** Restrictions on advanced chips and manufacturing equipment can limit the technological capabilities of rival countries in sensitive sectors, particularly AI and defence.

2. **Fragmentation of Global Supply Chains:** Export restrictions, investment screening and technology barriers encourage countries to develop separate technological ecosystems, potentially increasing costs and reducing

efficiency.

3. **National Security Concerns:** Controls seek to prevent sensitive technologies from reaching unauthorised military or intelligence users through intermediaries and diversion networks.

4. **Industrial Competition:** Restrictions incentivise domestic semiconductor manufacturing, research and technological substitution, accelerating competition for technological leadership.

Challenges

1. **Enforcement Difficulties:** Complex international supply chains and third-country intermediaries make it difficult to prevent diversion of restricted chips.

2. **Economic Interdependence:** Semiconductor production depends on specialised suppliers, equipment and expertise spread across several countries.

3. **Unintended Consequences:** Excessively broad restrictions can disrupt legitimate trade, research collaboration and global innovation.

Way Forward

1. Strengthen multilateral coordination on export-control standards and end-user verification.
2. Diversify semiconductor manufacturing and critical-material supply chains.
3. Invest in domestic research, chip design, fabrication and skilled human resources.
4. Maintain transparent, narrowly targeted restrictions consistent with legitimate security objectives.

Conclusion

Semiconductor export controls reflect the growing intersection of technology, trade and national security. India must strengthen domestic capabilities while pursuing diversified international partnerships to achieve strategic autonomy.